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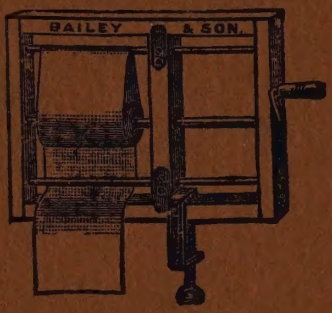

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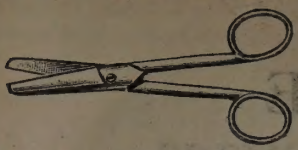

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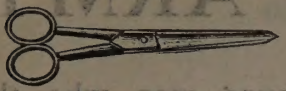

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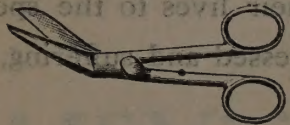

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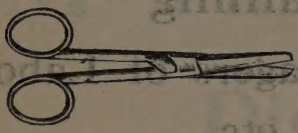

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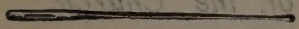

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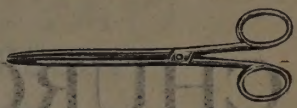

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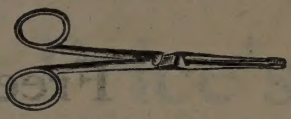

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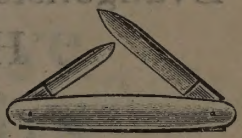

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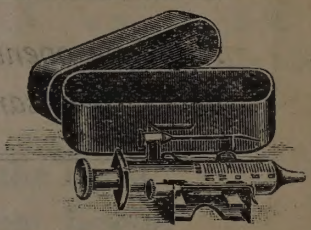

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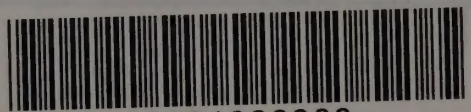
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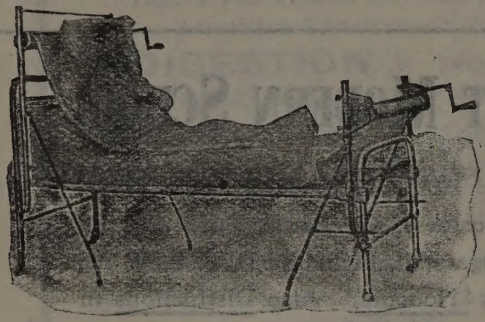

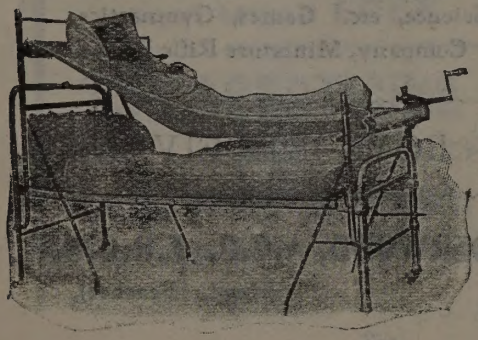

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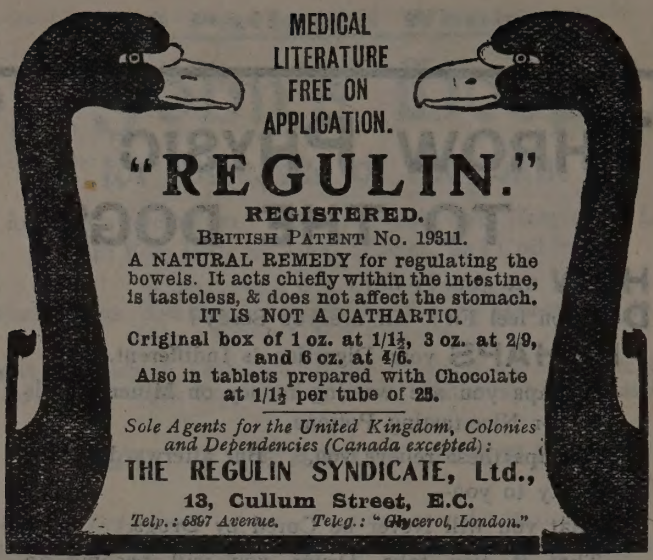
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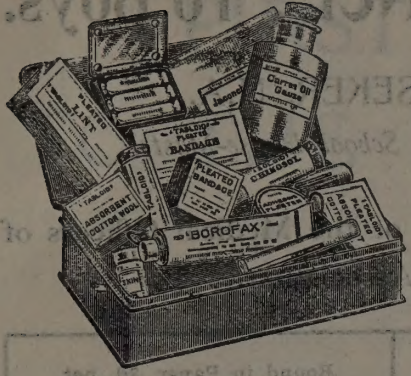

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CHAPTER I.

THE GENERAL STRUCTURE OF THE HUMAN BODY

Definition of Anatomy and Physiology—The Cell—The Amœba—The Properties of a Living Animal—The Amœba compared with higher Animals—Divisions of the Human Body—Hard and Soft Parts—The Systems.

Anatomy is the study of the *structure* of the body, and of the size, shape, and situation of the various organs which compose it.

Physiology is the study of the *uses* and *functions* of these various organs, and the way in which they do their work.

Every living creature, animal or vegetable, is composed of **Cells**.

A cell in its simplest form consists of a mass of a clear jelly-like substance called **Protoplasm** (from Greek words meaning 'the first thing formed'); in the interior of this mass of clear substance is a thicker and darker portion known as the **Nucleus**. The nucleus is, in fact, a sort of kernel, round which the protoplasm is gathered.

In order to understand the structure (anatomy) and functions (physiology) of a simple cell, we may take as an example the **Amœba**, one of the lowliest forms of animal life, which is found in ponds and ditches. A microscope is necessary, as the creature is too small to be seen without its aid. It will be found to consist of one single cell, an irregular mass of clear protoplasm with a nucleus inside. If we watch for a while, we

shall see that it is able to *move about*. This it accomplishes by stretching out a part of the protoplasm, as if it were a foot, and then drawing the rest of itself along.

In the course of its wanderings it comes across a small particle of matter, possibly a tiny mass of protoplasm smaller than itself. It thrusts out a part of its protoplasm, surrounds the particle and *takes it into itself*; presently the particle can be seen in the interior of the cell to have been broken up into smaller particles, and after a while these vanish; they have, in fact, been *eaten and digested* by the amœba. In the case of particles, such as mineral dust, which it cannot digest, it soon rejects them, or even refrains altogether from taking them in.

By further observation we shall see that after a time the nucleus of the cell, which has grown larger, divides into two parts; these separate from one another, each half taking with itself a portion of the protoplasm of the cell, and soon the whole cell is seen to divide completely so as *to produce two new amœbæ*, each resembling the original one in every particular.

The amœba, then, shows all the *phenomena characterizing a living animal*, namely:

1. The power of movement.
2. The power of receiving from outside matter which serves it as food.
3. The power of digesting that food and making it into protoplasm like itself.
4. The power of multiplying or reproducing itself.

The amœba, in fact, is an animal composed of one single cell; and every one of the functions or duties of a living animal is carried on by the same cell: the cell that moves is the same as the cell that digests and multiplies.

A higher animal, on the other hand, is made up of millions of cells, which are not all capable of doing anything and everything as is the amœba cell. In the human body, for instance, certain cells are told off for certain definite duties: some go to make *bone*, the supporting structure; others to make *muscles*, the organs of movement; others, again, are specially adapted for purposes of digestion; and so on. Moreover, one kind of cell cannot do the work of another kind: the muscle cell cannot

perform the duties of digestion, nor can the digestive cell do the work of a bone cell.

This division of the cells into groups, each group having its own special structure and function, makes the anatomy and physiology of the human body a much more complex study than that of the amœba, in which the several phenomena can be followed out in a single cell under the microscope.

The human body consists of the following parts:

I. **Head** (skull and face), which is connected by the neck to

II. **The Trunk**, which is divided into two cavities:

(*a*) The thoracic cavity,

(*b*) The abdominal cavity, which is again subdivided into

The abdomen proper,

The pelvis.

III. **Two Pairs of Limbs**, an upper and lower.

The structures entering into the composition of the body are:

i. A bony framework—the skeleton.

ii. Flesh covering the skeleton—the muscular system.

iii. The heart, bloodvessels and blood—the organs of circulation.

iv. The lungs and air-passages—the organs of respiration.

v. The brain, spinal cord, and nerves—the nervous system.

vi. The mouth, gullet, stomach, intestines, liver, spleen (milt), and pancreas (belly sweetbread)—the organs of digestion.

vii. The kidneys, ureters and bladder—the organs of excretion.

viii. The organs connected with reproduction.

ix. The skin (with its appendages—hair, nails, etc.) and underlying fat—forming a covering and padding for the whole body.

THE THORACIC CAVITY.

The Thorax.—This is an air-tight conical chamber, with walls composed of a bony framework (the dorsal vertebræ, the ribs

with their cartilages, and the sternum or breast-bone) and muscles; its upper end is closed in on each side by the first rib and the muscles at the root of the neck, its lower end by the midriff (diaphragm); the inner surface of the cavity is lined by a thin transparent membrane—the pleura.

The chief organs contained within the thoracic cavity are:

I. The two lungs, one placed in each lateral half of the chest, in which it is suspended by the bronchus and the pulmonary vessels, which enter it at a point behind, and a little above, the centre. This point is called the root of the lung.

II. The heart (surrounded by its membranous bag, the pericardium), placed between the lungs, lying obliquely across the lower two-thirds of the sternum and projecting more into the left than into the right side of the chest. Through the thoracic cavity passes the œsophagus (gullet).

THE ABDOMINAL CAVITY.

The Abdomen proper—with more or less flaccid walls—is formed behind by the lumbar vertebræ, in front and at the sides by muscles.

The inner surface of the abdomen is lined by a thin transparent membrane, the peritoneum, which also covers the surfaces of the abdominal organs, and attaches the greater part of the small intestine (the jejunum and ileum) to the backbone by a broad double fold, the mesentery.

The organs contained within the abdomen are:

I. The stomach.

II. The small intestine, consisting of three parts:
- (*a*) The duodenum.
- (*b*) The jejunum.
- (*c*) The ileum.

III. The large intestine, consisting of six parts:
- (*a*) The cæcum.
- (*b*) The ascending colon.
- (*c*) The transverse colon.

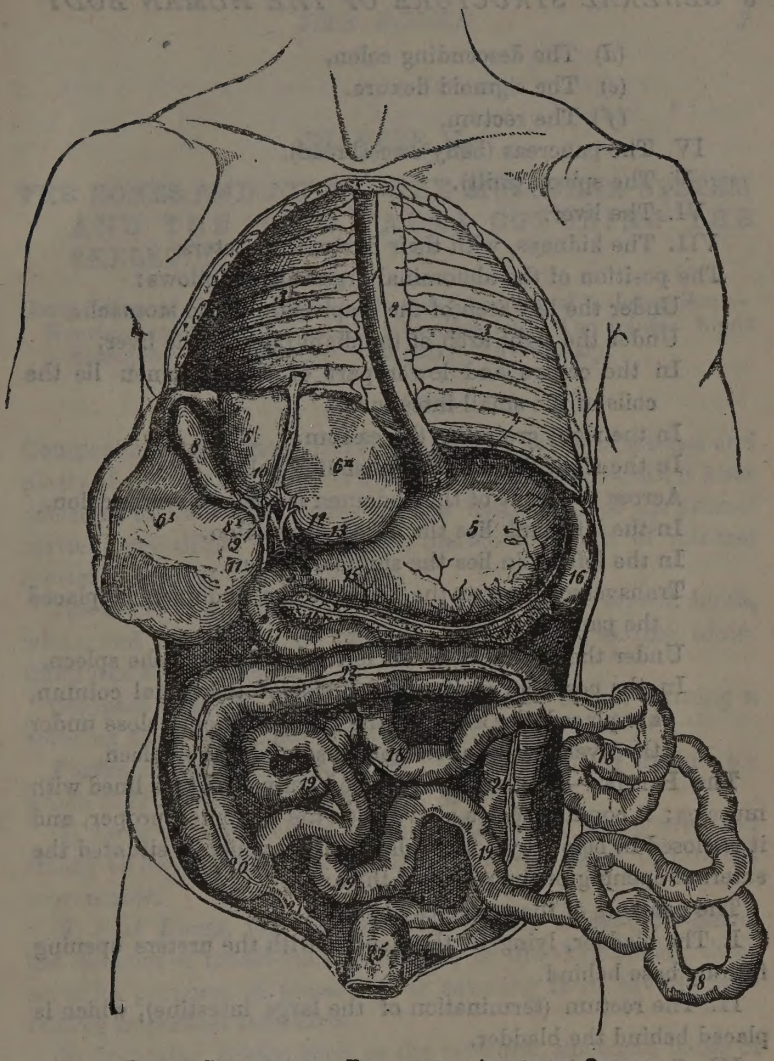


FIG. 1.—DIAGRAMMATIC VIEW OF THE ABDOMINAL ORGANS.

1. Œsophagus. 2. Spinal column. 3. Ribs. 4. Diaphragm. 5. Stomach. 5′. Fundus of the stomach. 5″. Cardiac orifice. 5‴. Pylorus. 6. Liver turned upwards. 6′. Right lobe of liver. 6″. Left lobe of liver. 7. Suspensory ligament of liver. 8. Gall bladder. 8′. Neck of gall bladder. 9. Gall duct. 10. Hepatic duct. 11. Common bile duct. 12. Portal vein. 13. Hepatic artery. 14. Pancreas; 15. Pancreatic duct; empties with the common bile duct into the duodenum. 16. Spleen. 17. Duodenum. 18. Jejunum. 19. Ileum. 20. Cæcum. 21. Vermiform appendix 22. Ascending colon. 23. Transverse colon. 24. Descending colon. 25. Rectum.

(*d*) The descending colon.
(*e*) The sigmoid flexure.
(*f*) The rectum.

IV. The pancreas (belly sweetbread).
V. The spleen (milt).
VI. The liver.
VII. The kidneys, with their ducts, the ureters.

The position of the abdominal organs is as follows:

Under the left arch of the diaphragm is the stomach.
Under the right arch of the diaphragm is the liver.
In the centre and lower part of the abdomen lie the coils of the small intestine.
In the right groin lies the cæcum.
In the right flank is the ascending colon.
Across the front of the abdomen is the transverse colon.
In the left flank lies the descending colon.
In the left groin lies the sigmoid flexure.
Transversely across the back of the abdomen is placed the pancreas.
Under the stomach, in the left side, is placed the spleen.
In the posterior wall, on each side of the spinal column, are placed the kidneys, the right one being close under the liver, and the left one close under the spleen.

The Pelvis.—This is a basin-shaped bony structure lined with muscles; it communicates above with the abdomen proper, and it is closed in below by a muscular floor, in which is situated the external opening of the rectum—the anus.

The contents of the pelvic cavity are:

I. The bladder, lying in the centre, with the ureters opening into its base behind.

II. The rectum (termination of the large intestine), which is placed behind the bladder.

III. Some of the organs of reproduction.

CHAPTER II.

THE BONES AND JOINTS—THE MUSCULAR SYSTEM AND THE SOFT PARTS COVERING THE SKELETON.

Composition of Bone—Forms of Bone—Structure of a Long Bone—Nourishment of Bone—Growth—Classification. The Joints: Kinds—Examples. The Muscles: Voluntary—Involuntary.

The Bones.

Composition of Bone.—Bone is composed partly of animal and partly of mineral matter. If a bone is calcined or burnt, it loses one-third of its weight, owing to the destruction of the animal matter; two-thirds of its weight, therefore, consist of mineral matter, chiefly phosphate of lime.

The tissue of a bone may be of two kinds: (1) *Compact*, dense, white, and like ivory; (2) *cancellous*, or spongy, looking something like a honeycomb.

Compact tissue is found on the outside of bones, forming a covering shell, and cancellous in the interior.

Forms of Bones.—Bones vary in form according to the uses which they serve. There are three varieties:

(1) *Long Bones*, such as those of the limbs, which are used chiefly as levers upon which muscles may act so as to produce movements.

(2) *Flat Bones*, for example, the scapula or shoulder-blade, the sternum or breast-bone, and many of the skull-bones; these serve for purposes of protection or covering in of cavities containing important structures.

(3) *Irregular Bones*, such as the vertebræ, the small bones of the hand and foot, etc. These have special uses according to their situation.

Structure of a Long Bone.—If we take, for example, the femur, or thigh-bone, we see that it consists of three parts: the *head*, or upper extremity; the *shaft;* and the *lower extremity*. The shaft is the narrowest part of the bone, which widens out

above and below. At each end of the bone will be found a smooth, ivory-like surface, which during life is covered with *cartilage*, or gristle, and forms part of a joint. About the middle of the shaft there is a small hole leading into the inside of the bone; this is the **Medullary Canal**; it affords a passage for the bloodvessels carrying nourishment to the bone. If we saw the bone in two from top to bottom, we find that the whole is covered with a layer of dense, compact bone; this ivory-like layer is much thicker in the middle of the shaft than at the extremities, where it thins out to a mere shell. The extremities are found to consist mainly of cancellous bone, which extends down into the shaft, but does not fill up the whole cavity. A large portion of the shaft is hollow, and is occupied during life by *marrow*. This hollowness of the long bones serves two purposes: first, it makes them light; secondly, it adds to their strength, a cylinder or tube being able to resist much more strain than a solid rod of the same diameter.

Nourishment of Bone.—Bones, like every other part of the body, receive their nourishment from the blood. Their blood-supply is twofold: (1) The *medullary artery*, passing in by the medullary canal and reaching the interior of the bone; (2) the small vessels of the *periosteum*, a tough fibrous sheath, which during life closely enwraps the bone, and needs considerable force to detach it.

Growth of Long Bones.—In the earliest stages of development a mass of cartilage is laid down in the situation of the future bone. This cartilage is composed of *cells* lying in a clear substance known as the **Matrix**. From the blood lime-salts are deposited in the matrix, and by a complex process bone is formed. Masses of cartilage persist for many years near the ends of the long bones, and by the growth of these, and extension into them of bony tissue, the bone is enabled to *grow in length* until the individual has attained his full stature. The *periosteum* is a source of new bone, as well as of nourishment to that which already exists; from it are formed layers of new osseous tissue on the surface of the old, and thus the bone *grows in thickness*.

Classification of Bones.—There are 214 bones in the adult

human body. Several of these are formed by the fusion of two or more bones into one mass. They may be grouped as follows:

I. **The Skull**, consisting of 28 different bones. These are divided into:

(1) 8 **Cranial** bones, forming the brain-case.

(2) 14 **Facial** bones, providing a framework on which the structures of the face are built up.

(3) 6 small bones inside the ears.

II. **The Bones of the Trunk**, 54 in number:

(1) **The Spinal Column** is made up of a number of irregularly-shaped bones, the **Vertebræ**, united by joints and elastic substance, so that, although the movement between each pair is slight in amount, the column as a whole is very flexible. The upper 24 vertebræ remain separate bones; below them is the **Sacrum**, a bone formed by the fusion of 5 vertebræ into one mass; the **Coccyx** is the lowest part of the spine, and is formed by the union of 4 rudimentary vertebræ.

A typical vertebra consists of two parts: the *body*, a thick, rounded portion lying in front; and the *neural arch*, formed by two thinner plates of bone springing from the sides of the body and meeting behind. The bodies of the vertebræ lie one above the other, with a thick pad of cartilage between each pair. This column of bodies bears the weight of the head, upper limbs, and trunk. The neural arches also lie one above another, and thus form a canal extending the whole length of the spinal column as far as the middle of the sacrum; in this canal is situated during life the **Spinal Cord**, from which nerves pass out on each side between the vertebræ to the tissues around and to the limbs.

(2) The **Sternum**, or breast-bone, forms the front of the thorax.

(3) The **Ribs**, twelve pairs, pass from the spinal column, where they are attached by joints, and form the sides of the thorax; in front the upper seven pairs are fastened by cartilages to the sternum; of the next three pairs each rib is attached to the cartilage of the one above; and the lowest two pairs, the **Floating Ribs**, are unattached in front.

The **Thorax**, in its natural state, when undeformed by disease or tight clothes, is a cone diminishing upwards, and truncated

(having its top cut off); the ribs being arched and elastic, and being attached in front by cartilage and behind by joints, are enabled to move freely up and down as the thorax changes its shape during the expansion of the lungs in respiration.

(4) The **Hyoid Bone**, shaped like a horseshoe, supports the tongue.

(5) The **Hip-Bone**, or **Innominate** (one each side), is formed by the fusion of three separate bones, viz., the ilium or hip-bone, the ischium or seat-bone, and the pubic bone.

The **Pelvis** is the basin-like cavity formed by the hip-bones at the sides and front, and the sacrum and coccyx behind.

III. **The Bones of the Upper Limbs**, 32 in each:

The **Clavicle**, or collar-bone; the **Scapula**, or shoulder-blade; the **Humerus**, or bone of the upper arm; the **Radius** and **Ulna**, or bones of the forearm; when the arm hangs by the side with the palm forward and the thumb outwards, the radius lies to the outer side of the ulna—that is to say, the ulna is nearer the mid-line of the body. There are 8 **Carpals**, or wrist-bones; 5 **Metacarpals**; and 14 **Phalanges**, or finger-bones.

IV. **The Bones of the Lower Limbs**, 30 in each:

The **Femur**, or thigh-bone; the **Patella**, or knee-cap; the **Tibia**, or shin-bone; the **Fibula**, a slender bone to the outer side of the tibia; 7 **Tarsal** bones; 5 **Metatarsals**; 14 **Phalanges**.

Besides all these, there are 8 **Sesamoid Bones**, formed near the joints of the thumb and great-toe, two to each.

The Joints.

Bones are connected together and move upon one another by means of joints. These are of different kinds:

I. **Immovable Joints.**

(*a*) The *Suture*, *e.g.*, the union of most of the skull-bones.

(*b*) The *Synchondrosis*, where cartilage is interposed between the bones, *e.g.*, the union of the hip-bones to the sacrum.

II. **Partly-movable Joints**, or symphyses, *e.g.*, the joints between the bodies of the vertebræ.

III. **Movable Joints.** In this form cartilage covers the ends of the bones forming the joint; these joint-surfaces are very smooth, and are lubricated by fluid secreted by a delicate

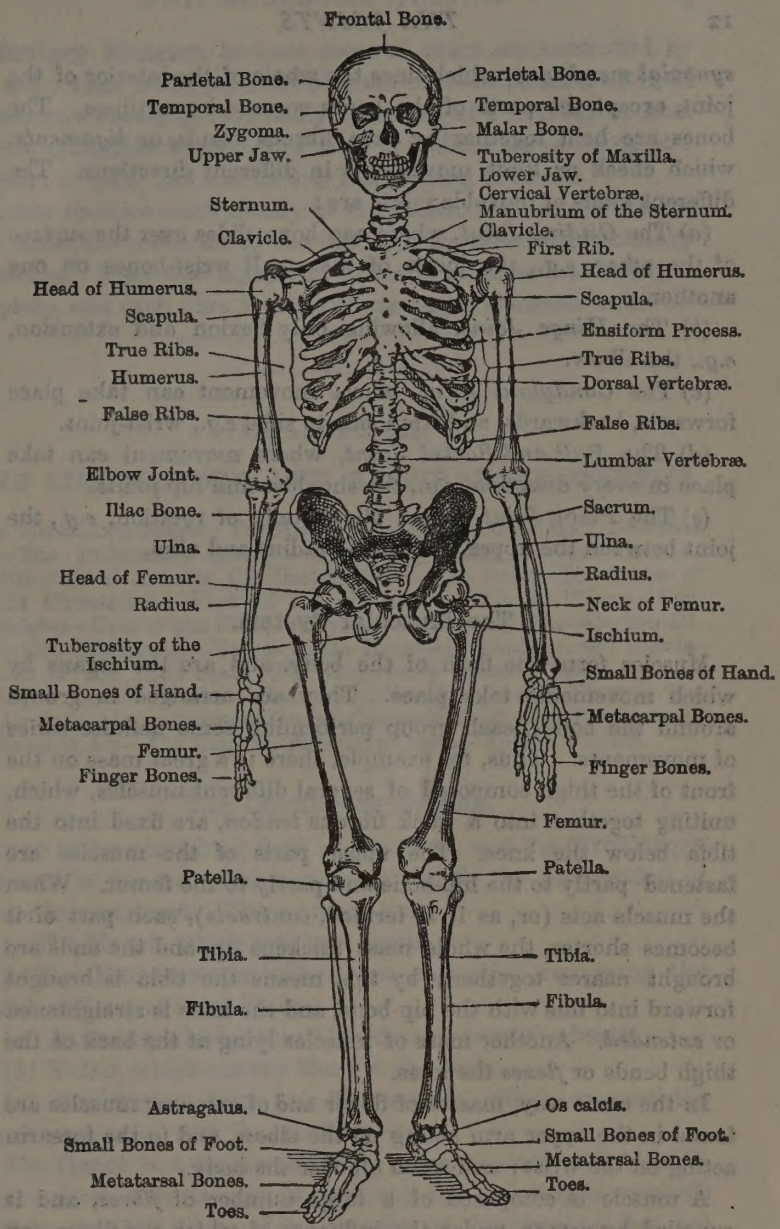


FIG. 2.—THE SKELETON.

synovial membrane, which lines the whole of the interior of the joint, except the parts of the bones covered by cartilage. The bones are held together by firm fibrous bands, or *ligaments*, which check or limit movements in different directions. The different kinds of movable joints are:

(*a*) The *Gliding Joint*, where one bone slides over the surface of the other, *e.g.*, the joints of the small wrist-bones on one another.

(*b*) The *Hinge Joint*, allowing only flexion and extension, *e.g.*, the elbow.

(*c*) The *Condyloid Joint*, where movement can take place forwards, backwards, and from side to side, *e.g.*, wrist-joint.

(*d*) The *Ball-and-Socket Joint*, where movement can take place in every direction, *e.g.*, the shoulder and hip joints.

(*e*) The *Pivot Joint*, which allows only of rotation, *e.g.*, the joint between the upper ends of the radius and ulna.

The Muscular System.

Muscles form the flesh of the body, and are the organs by which movements take place. They are arranged in groups around the bones, each group performing some definite series of movements. Thus, for example, there is a great mass on the front of the thigh composed of several different muscles, which, uniting together into a thick fibrous *tendon*, are fixed into the tibia below the knee. The upper parts of the muscles are fastened partly to the hip-bone and partly to the femur. When the muscle acts (or, as it is termed, *contracts*), each part of it becomes shorter, the whole mass thickens up, and the ends are brought nearer together; by this means the tibia is brought forward into line with the hip-bone, and the knee is straightened or *extended*. Another mass of muscles lying at the back of the thigh bends or *flexes* the knee.

In the same way, masses of flexor and of extensor muscles are found in the upper arm acting on the elbow, and in the forearm acting on the wrist; and so on all over the body.

A muscle is composed of a large number of *fibres*, and is supplied by nerves, under the influence of which the fibres can be made to contract. The skeletal muscles are often called

Voluntary Muscles, because most of them are controlled by the will; their fibres present under the microscope a cross-striped appearance; each fibre is really composed of a number of finer *fibrils*, lying side by side, and these fine fibrils are made up of a number of cells, laid end to end, like a string of beads.

Other muscles exist, chiefly in the internal organs, which are not under the influence of the will, and are called **Involuntary Muscles**. They also consist of fibres; but these are unstriped or plain, and each fibre consists of one single elongated cell.

CHAPTER III.

THE CIRCULATORY AND RESPIRATORY SYSTEMS.

The *Circulatory System:* The Heart—The Aorta and its Main Branches—The Pulmonary Artery — Pulmonary Veins — Venæ Cavæ — Structure of Arteries, Capillaries, Veins—The Pulse—The Course of the Circulation—Work of the Heart—The Blood—Plasma—Corpuscles—Uses of the Blood—Oxygen—Oxyhæmoglobin—Carbon Dioxide—Leucocytes—Nerves of the Heart—Distribution and Regulation of the Body-heat. The *Respiratory System:* The Larynx—Vocal Cords—Trachea—Bronchi—Cilia—Lungs and Pleuræ—The Air Cells—Interchange of Gases—Composition of Air—Inspired and Expired Air—The Lung an Excretory Organ—Animal Poisons.

The Circulatory System.

Blood is the nourishing fluid of the body, and the **Circulatory System** is the set of organs concerned in the distribution of blood to every part. These organs are:

1. The **Heart**, which acts as a pump.

2. The **Bloodvessels**, which are the pipes conveying the blood, and are of three kinds:

(*a*) **Arteries**, which convey blood away from the heart.

(*b*) **Veins**, which convey blood to the heart.

(*c*) **Capillaries**, tiny hair-like vessels, which connect the smallest arteries with the smallest veins.

The **Heart** is a hollow muscular organ situated in the middle of the chest, with its *apex*, or narrower end, pointing downwards and to the left. It is about the size of the clenched fist, and

weighs in health about 9 ounces. It is enclosed in a bag or sac, the **Pericardium**. The cavity of the heart is divided into two halves, the right and left, by a muscular partition; and each half is further divided into an upper part, the **Auricle**, and a lower part, the **Ventricle**; the opening between the auricle and ventricle of each side is closed by membranous flaps or valves. The right and left sides of the heart do not communicate directly with one another, but are completely separated by the aforesaid muscular partition. Of all the four cavities of the heart, the left ventricle has the thickest and strongest walls; each time the heart beats the muscular walls contract and squeeze blood on from one cavity to another; the left ventricle has to pump blood through the arteries to the most distant parts of the body, and therefore, much force being needed, its walls are proportionately thick and powerful.

The right auricle opens into the right ventricle by an oval orifice, which would easily admit three fingers. To close this orifice when necessary there is a trap-door arrangement opening downwards towards the ventricle in the form of three membranous flaps, which together constitute the **Tricuspid Valve**.

A similar arrangement is found on the left side of the heart; here, however, the orifice between the auricle and ventricle is rather smaller, and is closed by two flaps, the **Mitral Valve**, so called because the ancients who discovered it thought it resembled a bishop's mitre.

The flaps of these valves are prevented from floating back into the auricles when the ventricles fill by little fibrous cords extending from their edges to the walls of the ventricles.

The arterial system begins with the **Aorta**, a large vessel passing up from the left ventricle. The opening between the aorta and the ventricle is guarded by three pocket-shaped flaps, the **Semilunar Valves**, which by their closure prevent blood from flowing back into the ventricle from the aorta.

The **Pulmonary Artery** leaves the right ventricle, the opening being guarded, as in the case of the aorta, by three semilunar valves. It divides into two, one branch entering each lung. All the blood must pass by means of the pulmonary artery to

the lungs to be purified. It returns to the heart from the lungs by four **Pulmonary Veins** which open into the left auricle.

From the other parts of the body the blood is brought back by large veins, which ultimately gather themselves into two big vessels, the **Superior Vena Cava**, bringing blood from the head, neck, and upper limbs, and the **Inferior Vena Cava**, bringing blood from all the lower parts; these two trunks open into the right auricle.

The Main Arteries of the Body.—The Aorta, the principal artery of the body, starts from the left ventricle. It passes upwards on the right side of the spine, and then arches across to the left side, descending along the left side of the spine; in the thorax it pierces the diaphragm, passes into the abdomen, and divides opposite the fourth lumbar vertebra into two branches—the iliac arteries.

From the arch of the aorta three trunks arise:

1. From the right side of the arch, the **Innominate** artery, which divides into

(*a*) The **Right Common Carotid**, carrying blood to the right side of the head and neck.

(*b*) The **Right Subclavian**, to the right upper limb.

2. The **Left Common Carotid**, the second branch, to the left side of the head and neck.

3. The **Left Subclavian**, the third branch, to the left upper extremity.

Each common carotid artery divides on a level with Adam's apple into branches:

(*a*) The **Internal Carotid**, which goes to the brain.

(*b*) The **External Carotid**, which supplies branches to the head and face.

The **Subclavian** artery passes in an arch over the first rib to its lower edge, and is continued into the armpit (axilla) as

The **Axillary**, which extends across the axilla into the arm, where it is continued as

The **Brachial**, which passes along the inner border of the biceps muscle to an inch below the bend of the elbow; here it divides into two branches:

(*a*) The **Radial** artery, which extends along the outer side of the forearm to the wrist.

(*b*) The **Ulnar** artery, which extends along the inner side of the forearm to the wrist.

In the palm the radial and ulnar are connected by two vessels —the superficial and deep **Palmar** arches, from which branches are given off to the fingers and hand.

In the thorax the aorta gives off a number of branches, the chief being:

The **Intercostal** arteries—ten on each side—to supply the chest-wall.

In the abdomen the principal vessels given off by the aorta are:

(*a*) The **Gastric**—to the stomach.

(*b*) The **Splenic**—to the spleen.

(*c*) The **Hepatic**—to the liver.

(*d*) The **Renal**—to the kidneys.

(*e*) The **Mesenterics**—to the intestines.

The **Common Iliac** arteries pass into the pelvis, and divide into two branches on each side:

(*a*) The **Internal Iliac**—to the organs in the pelvis.

(*b*) The **External Iliac**, which passes along the wall of the pelvis to the middle of the fold of the groin; here it emerges from the abdomen, enters the thigh, and becomes

The **Femoral**, which passes down the thigh to the inner side of the knee and into the ham, where it becomes

The **Popliteal**, which passes along the middle of the ham, and just below the bend of the knee divides into

(*a*) The **Anterior Tibial**, which coming to the front between the two bones of the leg passes down to the ankle, and is continued on to the upper surface of the foot as the **Dorsalis Pedis** artery.

(*b*) The **Posterior Tibial**, which runs down the back of the leg, and passes round behind the inner ankle to the sole of the foot; it gives off as a branch the **Peroneal** artery, which passes down the back of the leg to the heel and outer ankle. On entering the sole the posterior tibial artery divides into two branches:

(*a*) The **External Plantar** artery.

(*b*) **The Internal Plantar artery.**

These supply the toes and sole of the foot.

Structure of Bloodvessels.—The **Arteries** after death are found to be empty of blood, and for that reason the ancients thought that during life they contained air. The word 'artery' comes from two Greek words meaning 'air-containing.'

The wall of an artery is composed largely of plain muscle fibres and elastic tissue. This elasticity is very important; if the arteries were rigid and could not expand, the flow through them would be by intermittent jerks, each jerk corresponding to a heart-beat; the artery, however, expands as the blood is forced into it by the heart, and this expansion can be felt as the **Pulse** in parts of the body, such as the wrist or temple, where an artery comes near the surface. When the heart-beat is over, the artery contracts on the blood in it, forcing it onwards into the tissues until the next heart-beat fills and expands it once more. By this means a continuous supply of blood is kept up.

In some parts of the body arteries run into one another; this is called **Anastomosis**. By this arrangement, if one artery is blocked by disease or injury, the blood can pass to the tissues by way of the other channel which remains open.

As the arteries branch and become smaller, their walls become less muscular and less elastic; and when the **Capillaries** are reached, we find that these tiny vessels consist of a single layer of cells, with no muscular or elastic tissue at all in their walls. It is in the capillaries that the work of the blood is done, which, as we shall see, is twofold—(*a*) the giving of nourishment to the tissues, and (*b*) the receiving of waste matter from them; the thinness of the capillary wall enables this to be done.

The **Veins** are much less elastic and muscular than the arteries, and collapse when cut across, while an artery remains open. Many of them have pocket-like flaps or valves set on the inside, which keep the blood from flowing backward in the vein.

In order to understand the anatomy of the circulation, let us follow the blood through its course.

Impure blood enters the right auricle from the venæ cavæ; when full, the auricle contracts, forcing the blood into the right

ventricle; as this fills, the tricuspid valve floats up and closes the opening into the auricle; the right ventricle now contracts and drives the impure blood through the pulmonary artery to the lungs to be purified. **Pure blood** returns through the pulmonary veins to the left auricle; when the left auricle is full it contracts, and forces its contents into the left ventricle; this in its turn fills, the mitral valve closes, and the blood is pumped by the contracting ventricle into the aorta, and so all over the body. It passes from the larger arteries into smaller and smaller vessels till the network of capillaries is reached. Here the blood does its work, giving up oxygen and other nourishment to the tissues, and picking up from them waste materials to be conveyed away and disposed of. In an impure state it now passes on into the smallest veins, and thus through larger and larger veins it reaches the vena cava, and so returns to the heart. It must be remembered that both sides of the heart *act together*, so that while impure blood is being purified in the lungs, pure blood is being pumped into the tissues.

It will be seen that the circulation of the blood in the body has a double course; there is

(*a*) **The Systemic or Larger Circulation**—the circulation through the arteries of the body by means of which pure blood is distributed to every part.

(*b*) **The Pulmonic Circulation**—the circulation through the arteries of the lungs by means of which the impure blood is purified.

The Work of the Heart.—Each heart-beat means a contraction of the whole of the muscular substance of the heart. This occurs, on an average, seventy-two times in a minute, or more than 100,000 times in a day. It is easy to see that the daily work of the heart is very considerable. During sleep the other muscles are resting and motionless; but the heart goes on all the time. The daily work of the heart is calculated by Foster to be equal to 'the amount of work done in the ascent of Snowdon by a tolerably heavy man.'

The Blood.—The blood consists of two parts, solid and liquid. The liquid portion is known as **Plasma**, and contains dissolved in it albumin with other nutritive substances and mineral matter.

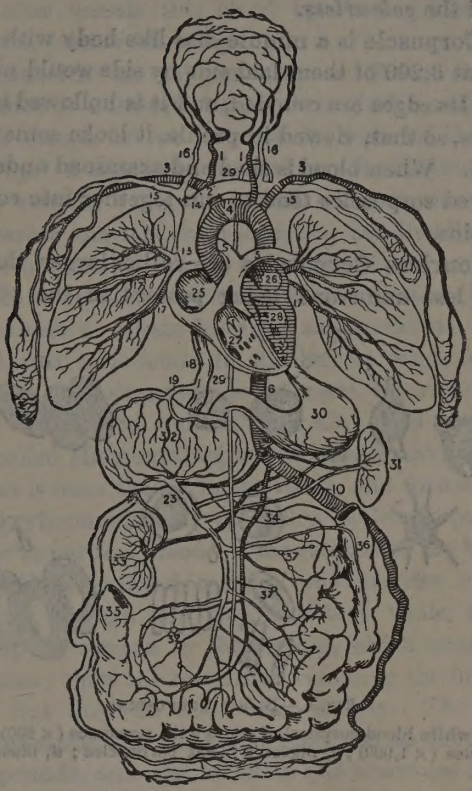


FIG. 3.—THE CIRCULATION OF THE BLOOD (diagrammatic).

1, The carotid arteries; 2, the innominate artery; 3, the subclavian arteries; 4, the arch of the aorta; 5, the pulmonary arteries; 6, the thoracic aorta; 7 and 10, the abdominal aorta; 8, the hepatic artery; 9, the splenic artery; 11, the superior mesenteric artery; 12, the renal artery; 13, the superior vena cava; 14, the right innominate vein; 15, the subclavian vein; 16, the internal jugular vein; 17, the pulmonary veins; 18, the inferior vena cava; 19, the hepatic vein; 20, the gastric vein; 21, the splenic vein; 22, the superior mesenteric vein; 23, the portal vein; 24, the renal vein; 25, the right auricle; 26, the left auricle; 27, the right ventricle; 28, the left ventricle; 29, the thoracic duct; 30, the stomach; 31, the spleen; 32, the liver; 33, the kidneys; 34, the duodenum; 35, the ascending colon; 36, the descending colon; 37, abdominal lymphatic glands.

It is colourless in itself, the red colour of the blood being due to one of the solid constituents.

The solid constituents of the blood are the **Corpuscles**, which

float about in the plasma. These corpuscles are of two kinds, the *red* and the *colourless*.

A **Red Corpuscle** is a minute disc-like body with no nucleus, so small that 3,200 of them laid side by side would measure only one inch. Its edges are rounded, and it is hollowed in the centre on each side, so that, viewed in profile, it looks somewhat dumb-bell-shaped. When blood is shed and examined under the microscope, the red corpuscles tend to run together into rouleaux, like heaps of coins.

The **Colourless Corpuscles** are rather larger than the red, and much less numerous, being present in the proportion of

FIG. 4.—BLOOD CORPUSCLES.

a, Human white blood corpuscles, some with processes (× 800); *b*, human red blood corpuscles (× 1,000); *c*, pigeon's blood corpuscles; *d*, blood corpuscles of a frog (× 800).

1 colourless to about 500 red corpuscles. They are rounded cells with a nucleus, closely resembling the amœba; they can move about and change their shape. Similar cells are found all over the body, not only in the blood, but in certain organs, and loose in the tissues. The general name of **Leucocyte** has been given to all these cells.

Uses of the Blood.—The plasma carries albumin and other nutritive matter to the muscles and other organs, and lime and phosphates to the bones, and takes away from the tissues certain waste matters to be disposed of elsewhere.

Plasma also contains a substance which, under certain conditions, produces **clotting or coagulation of the blood**; when

a bloodvessel is cut or injured, blood is shed from it, and in the case of the smaller vessels this blood by clotting closes the vessel and prevents further bleeding.

The **Red Corpuscles** are oxygen-carriers. Every time an action is performed or a thought passes through the mind, each time a breath is drawn or the heart beats, some of the body tissues are used up. A constant wear and tear is going on; parts of the body are actually being consumed, or, as it were, being burnt up, and waste matters, or ashes, are continually being formed. This combustion keeps up the heat of the body, and cannot take place without the presence in the tissues of a gas called **Oxygen**, which we obtain from the air around us.

Impure blood, such as is found in the largest veins, contains very little oxygen; it is pumped by the right ventricle to the lungs, where it comes into contact with air. Red corpuscles contain a body called **Hæmoglobin**, which has a great attraction for oxygen, seizes it from the air in the lungs, and forms with it a body called **Oxyhæmoglobin**; it is this which imparts the bright red colour to purified blood. This returns to the left side of the heart, and is pumped through the arteries into the capillaries. Here, through the thin capillary walls, the red corpuscles give up the oxygen to the tissues, which need it for their various duties; then the corpuscles return to the lungs for more oxygen. But they do not return empty. The tissues during their combustion (or wear and tear) use up oxygen and form other compounds, amongst which is one known as **Carbon Dioxide** (sometimes called carbonic acid). This is poisonous, and would, if it were not got rid of, choke up the system. The red corpuscles, having given up their oxygen, take in exchange the carbon dioxide. This gives the blood returning to the heart by the venæ cavæ a dull purple colour. It reaches the lungs; the red corpuscles give up the carbon dioxide to the air, receiving from it oxygen, with which they hasten back to the tissues. The carbon dioxide is breathed out, and thus leaves the body.

The **Leucocytes**, or colourless corpuscles, have two important duties. First, they act as *scavengers*, picking up and destroying germs of disease and other noxious particles; secondly, they limit the effect of injuries, and promote the healing of wounds.

When a part is injured, crowds of leucocytes rush in from neighbouring parts to the spot, and surround it as by a wall, so as to prevent the injury from spreading. After a while, some of these leucocytes change into fibrous tissue, and produce healing of the wound.

The Nerves of the Heart.—The heart, like every other muscle in the body, has a supply of nerves which control its action. This nerve-supply is twofold:

(*a*) Some of the nerves come from the **Vagus**, a large nerve passing out from the skull and sending branches to the respiratory and digestive organs, as well as to the heart. This set of nerves controls or *inhibits* the heart's action; they keep it in check, and prevent it from beating too quickly.

(*b*) Other nerves come from the **Sympathetic Chain**, which will be considered in a future chapter. These nerves tend to quicken the heart.

By a nice adjustment these two sets of nerves in health balance one another, keeping the heart's action regular, or modifying it to suit circumstances. In disease either of the sets of nerves may be thrown out of order, and the heart's action is thus upset.

Distribution and Regulation of the Body-Heat.—The body-heat is kept up by the combustion that is continually going on in the tissues. This, as we saw, is carried on by means of the oxygen which reaches them through the blood. The natural average temperature of the human body is between 98° and 99° Fahr.

The heat of any part of the body depends upon its blood-supply: if from any cause this is cut off, combustion cannot go on in the tissues of the part, because no oxygen can reach them; the part, therefore, grows cold and dies.

The amount of heat in the body is regulated by a set of nerves passing to the muscular walls of the smallest arteries in the skin and lining membrane of the respiratory tract; these nerves are controlled by **Heat-Centres** in the brain. When there has been a great deal of combustion, as after violent exercise, the body tends to become too warm; the nerves of the heat-regulating mechanism are called into play; the small bloodvessels of the

surface expand, more blood flows through them and distends the capillaries; fluid exudes and is taken up by sweat glands in the skin, from which it pours as perspiration. By the evaporation of this fluid the body is cooled.

When the body-temperature tends to fall too low, the vessels of the surface contract, less blood passes through them, and less fluid exudes, so that there is a diminution of the loss of heat by perspiration.

The Respiratory System.

We have seen how essential is oxygen for the continuance of life. The main supply of this gas is the air around us, and the respiratory system is the set of organs concerned in the breathing in of this all-important substance. Air can enter the body in two ways—by the mouth and by the nose; these passages open at the back of the throat into the **Pharynx**. The air then passes into the **Larynx**, a cartilaginous box which can be felt in the front of the neck, and which is open above and below. The upper opening of the larynx is close to the root of the tongue, and is called the **Glottis**; between the glottis and the tongue is a spoon-shaped piece of cartilage, the **Epiglottis**; when food is swallowed, the epiglottis closes down over the glottis and prevents food from passing into the larynx.

The whole larynx is lined with a membrane which, on each side of the glottis, is drawn into an elastic fold. These folds almost meet in the mid-line, leaving a narrow chink for the air to pass through; they are the **Vocal Cords**. Their tension can be altered by means of a wonderful arrangement of small muscles; air passing the larynx throws the cords into vibrations, and by changes in their tension the different tones of the voice are produced.

The lower end of the larynx opens into the **Trachea**, or windpipe, a tube strengthened by horseshoe-shaped pieces of cartilage which can be felt in the lower part of the neck. It is about 4 inches long, and passes down into the chest.

Here it divides into two branches, the **Right and the Left Bronchus**, one of which passes to each lung. On entering the lung, the bronchus divides again and again, its branches becoming

ever smaller and thinner-walled, and ramifying all over the lung. The smallest branches of all open into the air-cells of the lung.

The air-passages are lined with a layer of cells, each studded with fine hair-like processes, projecting finger-wise into the cavity of the tube. These finger-like projections are called Cilia

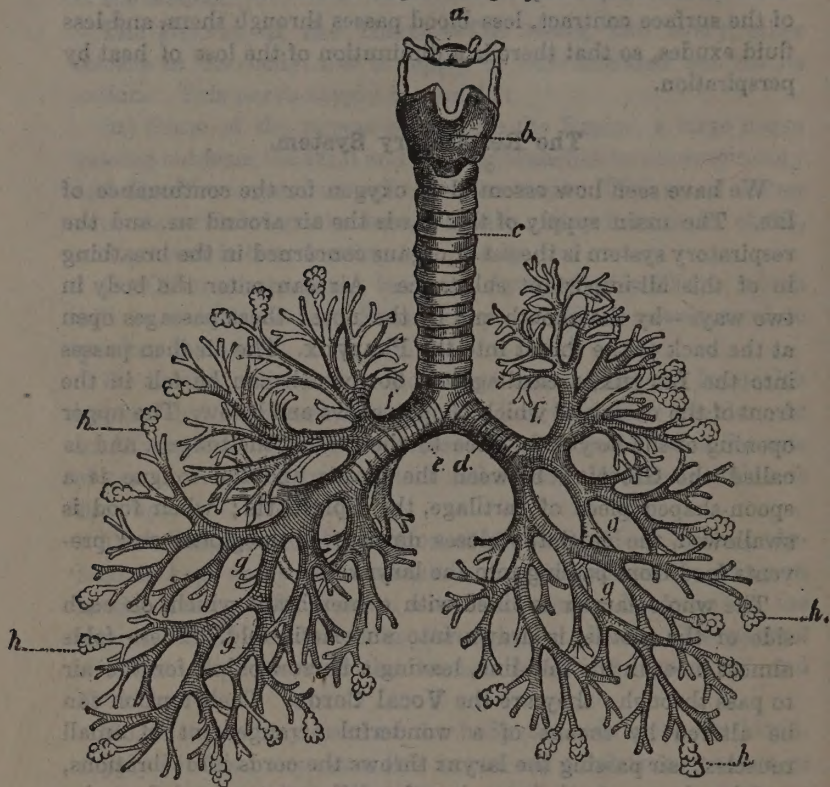


FIG. 5.—LARYNX, TRACHEA, BRONCHI (diagrammatic).

a, Hyoid bone; *b*, larynx; *c*, trachea; *d*, left bronchus; *e*, right bronchus; *ff*, larger bronchi; *g*, smaller bronchi; *h*, cells of the lungs.

and they are continually moving backwards and forwards. They have the power of sweeping dust and foreign particles breathed in with the air, outwards and upwards, and so prevent a great deal of injurious matter from reaching the delicate air cells.

The Lungs are two in number, the right and the left. They

occupy the greater part of the thorax; they are larger below than above, where they taper to a blunt apex.

Each lung is encased in a double bag of membrane, the **Pleura**. The two lungs together weigh about 40 ounces. The substance of the lungs is spongy, porous, and very elastic; they float in water, owing to the air which they contain. Each is made up of minute **Air Cells**, in the walls of which is a network of capillary bloodvessels. These capillaries are the outcome of the branching of the pulmonary artery, and they unite to form the small veins which, by further union, ultimately become the pulmonary veins. The walls of the air cells are so thin that an interchange of gases can take place between the air in them and the blood in the capillaries. Oxygen passes into the blood from the air cell, and is seized by the red corpuscles; while carbon dioxide passes into the air cell from the blood and is breathed out.

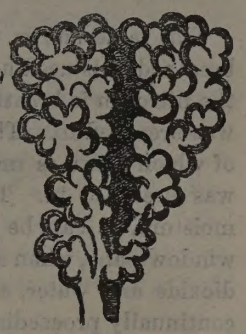


FIG. 6.—AIR CELLS OF THE LUNG AND BRONCHUS.

A healthy adult breathes in and out from sixteen to twenty times per minute, about 25,000 times in twenty-four hours, and requires 3,000 cubic feet of air per hour.

Composition of Air.—Inspired Air, that which we breathe into our lungs from the surrounding atmosphere, is a mixture of gases, the two most important of which are **Oxygen** and **Nitrogen**.

Oxygen, as we have seen, is a vital necessity; the body cannot live for even a few minutes without it; and we obtain it from the air. Nitrogen is just as necessary to life as oxygen; but although we take it in in the air we breathe, the atmospheric nitrogen is not used up in the body; it returns in practically the same amount as it entered. We get the nitrogen we require from other sources than the air. Its use in inspired air is to dilute the oxygen to the proper proportions. Besides these two gases, traces of other substances are found, among them carbon dioxide, which in good air occurs in very small proportion.

Expired Air, which we breathe out from our lungs, contains

the same gases, but in very different proportions, and is also saturated with moisture.

If we take 100 volumes of inspired air and compare it with 100 volumes of expired air, we shall find the proportions of the constituents to be roughly as follows:

	Inspired Air.	*Expired Air.*
Oxygen	20·81	16·033
Nitrogen	79·15	79·587
Carbon dioxide ...	·04	4·38
	100·00	100·000

This table shows us that about one-fifth part of the oxygen breathed in is used up in purifying the blood. We also see that the nitrogen is breathed out in almost the same proportion as it was breathed in. The greatest change is in the carbon dioxide, of which there is more than 100 times as much breathed out as was breathed in. The air breathed out is also saturated with moisture, as can be seen by breathing on a cold surface, like a window-pane, when a film forms. These two substances, carbon dioxide and water, are two of the products of the combustion continually proceeding in our bodies. They are, in fact, waste materials, or ashes; and the lungs are one of the channels by which these waste products leave the body; such a channel is known as an **Excretory Organ**. The most important of the excretory organs are the **lungs, kidneys,** and **skin.**

Carbon dioxide is a poisonous gas; a candle cannot burn in an atmosphere of carbon dioxide; and when this gas reaches to a certain proportion in the air, as in a crowded, stuffy room, where people have been breathing the same air over and over again, symptoms of poisoning arise, such as headache, oppression giddiness, and faintness. This poisonous effect is produced not only by the carbon dioxide, but also, and to a greater extent, by the presence in the expired air of certain **animal poisons** given off from the body through the lungs.

CHAPTER IV.

THE ORGANS OF DIGESTION AND EXCRETION.

Food: The Food-stuffs and their Uses—Digestion—Excretion. The *Organs of Digestion:* Mastication—Saliva—The Œsophagus—The Stomach—Gastric Juice—Chyme—The Pylorus—Peptones—The Small Intestine—The Liver and Bile—The Pancreas and its Secretion—Chyle—Peristaltic Action. *Absorption:* The Portal Vein—Glycogen—The Lacteals—Thoracic Duct—The Large Intestine. *Excretion:* Waste Materials—Urea—Channels of Outlet—The Skin—Hair and Nails—Sebaceous Glands—Sweat Glands—Perspiration—The Kidneys—Table showing the Processes of Digestion, Absorption and Excretion.

Our daily life involves a continual giving out of heat and using up of energy and force. This double process means a constant wear and tear, an actual consumption of material, and obviously demands a constant renewal of the sources of energy and heat. **Food** is the means whereby our bodies are repaired and maintained. It has been found that, in order to keep the body in an active and efficient state, we require certain definite kinds of food in certain proportions.

The food-stuffs that we need are of four classes:

1. **Nitrogenous Food**, or **Proteids**, which contributes to the growth and nutrition of the tissues, and provides some amount of heat and force. The commonest sources of nitrogenous or proteid food are lean meat, fish, white of egg, casein (the chief constituent of cheese), oatmeal.

2. **Carbo-hydrates** are used for the formation of fat and the production of force and heat. They are present in sugar and starches, such as bread, potato, cereals.

3. **Fats** are applied to the production of heat and other forms of force. We obtain them in the form of butter, cream, and animal and vegetable fats and oils.

4. **Mineral Matter**, including water, iron, lime, phosphorus, and various salts.

Water forms two-thirds of the body-weight, and is found in every tissue. Water dissolves the food, and carries it all over the body. Food cannot be digested before it is dissolved.

Iron is needed to form the colouring matter of the blood; lime is essential to bone formation.

If the food were to be cast into the blood in the state in which it was eaten, it could not be used by the tissues. It needs to be acted upon and changed in many ways by the organs of digestion before it can be absorbed by the blood and used in the body. The whole of the digestive tract is lined with a **membrane**, through which the food must pass before it can reach the blood and be carried to the tissues. The food-stuffs as we take them into our mouths are, for the most part, not in a state to pass through this membrane; they are said to be *non-diffusible*. They must be acted upon by the different organs of digestion and the various digestive juices, and so changed as to become *diffusible, or capable of passing through the lining membrane of the digestive tract.* This process of changing non-diffusible substances into diffusible ones is **Digestion.**

During life the activities of the body produce a great deal of waste material, which must be got rid of out of the body if health is to be good. The process of ridding the body of waste matter is known as **Excretion.**

The Organs of Digestion.

The processes of digestion are carried on in a canal, which begins at the mouth, passes through the neck and trunk, and ends at the anus.

The first process to which the food is subjected is **Mastication.** This is carried on by the **Teeth,** which in an adult should number thirty-two. By this means the food is thoroughly ground up and broken into small fragments, so that it can better be exposed to the action of the digestive juices.

During the process of mastication the food comes into contact with the first of the digestive fluids, the **Saliva.** This is a clear fluid, poured into the mouth by three pairs of glands, situated in the cheeks and below the tongue. It has three uses:

1. It moistens food and aids swallowing.
2. It dissolves some of the minerals and salts.
3. It acts specially upon the starchy part of the food, which is

non-diffusible, and converts it into **Grape-sugar**, which is diffusible. The active principle of saliva is a substance called **Ptyalin**, which belongs to a class of bodies known as **Ferments**.

The food, now ready to be swallowed, is formed by the muscles of the mouth and tongue into a rounded ball, and passes into the gullet, or **Œsophagus**—a muscular tube passing down the neck into the thorax, through an opening in the diaphragm, to open into the stomach, situated under the heart, below the diaphragm, in the left upper part of the abdomen.

The **Stomach** is a muscular bag, capable of holding about 3 pints; it can be distended or stretched. Its muscular walls are composed of plain (unstriped) fibres. It is lined by a mucous membrane, which is studded with small glands; these glands secrete a fluid called **Gastric Juice**. When the food enters the stomach two things happen: (1) The muscular walls of the organ begin to contract; (2) the gastric juice begins to flow in and mix with the food.

By the former process, the food is still further pounded and ground; this occupies from one to four hours, and by this time the food becomes converted into a greyish, thick, soupy mass called **Chyme**. All the time the action of the stomach has been going on, the food is prevented from passing on into the small intestine by the narrowing of the opening between it and the stomach. This opening is the **Pylorus**, and only allows the food to pass through when the stomach has done its work.

The second process—the admixture of gastric juice with the food—produces important changes in the nitrogenous or proteid part of the meal. **Proteids** are non-diffusible substances; gastric juice contains a ferment, **Pepsin**, which can convert proteids into diffusible **Peptones**.

Having passed through the pylorus, the food now enters the **Small Intestine**. This is a tube, 20 feet in length, coiled upon itself in a complicated manner, and occupying a large part of the abdomen. The first 12 inches of it are known as the **Duodenum**; the next 7 or 8 feet are called the **Jejunum**; and the rest is the **Ileum**, and opens into the **Large Intestine**. Into the duodenum opens a little canal, which conveys the secretions of the liver and pancreas.

The **Liver** is the largest gland in the body, and weighs between 3 and 4 pounds. It is situated in the right side of the abdomen, below the diaphragm, and under cover of the ribs. It secretes a digestive juice, the **Bile**, the use of which is principally to aid the action of the pancreatic secretion.

The **Pancreas** is a gland lying across the spinal column behind the stomach. Its secretion is known as **Pancreatic Juice**, and is very important, as it acts very vigorously on proteids, carbo-hydrates, and fats. On **proteids** it acts like gastric juice, finishing off the conversion of them into peptone which was begun in the stomach; this is done by a ferment called **Trypsin**, and this substance carries the digestion of proteids further than does pepsin, for it separates out from them certain waste substances which are not absorbed, but pass away with the other indigestible portions of the food.

On **starch** (carbo-hydrate) it acts like saliva, but far more rapidly and energetically; saliva only converts part of the starch into grape-sugar; pancreatic juice finishes off the process, converting the remainder of the starch into **malt-sugar**.

On **fats**, pancreatic juice, helped by the bile, acts with great vigour, *emulsifying* them—that is, breaking them up into very minute particles. This is a necessary prelude to their absorption, for large fat droplets cannot pass through the lining membrane of the digestive tract, whereas the tiny droplets of an emulsion can do so.

By the action of the bile and pancreatic juice, the food becomes converted into a creamy fluid, the **Chyle**. In this condition it passes along the small intestine, being forced onwards by peculiar worm-like contractions of the tube, whose walls are muscular; this is known as **Peristaltic Action**. Absorption takes place chiefly from this part of the digestive tract.

Absorption.—The chyle consists of a mixture of diffusible substances—peptones, sugars, and fats in a state of emulsion. This state of affairs has been brought about by the action of different digestive juices upon the non-diffusible proteids, starches, and fats.

In the walls of the intestine are found three sets of vessels—arteries, veins, and lacteals.

The **Arteries** are branches of a large trunk coming from the aorta, and contain pure blood to nourish the muscular wall of the tube and its lining membrane.

The **Veins** are small vessels, which take a large share in the absorption of food. In the walls of the stomach they begin their work, taking up water and dissolved salts, and as much of the nitrogenous food as has been converted into peptone, also the sugars formed by the action of the saliva on starch. In the intestine, the veins suck through the lining membrane the rest of the peptones and sugars, water and salts. These small vessels unite into larger ones. By the union of large veins from the stomach, intestine, pancreas, and **spleen** (an organ situated on the left side of the abdomen behind the stomach), there is formed a very large vessel known as the **Portal Vein.** This passes to the liver, and forms by its branchings a network throughout that organ. The blood which reaches the liver by the portal vein is rich in nourishment, containing as it does all the products of digestion except the fats. The sugar is stored up in the liver in the form of **glycogen,** to be served out to the body as it is required. The blood, having passed through the network formed by the branchings of the portal vein, leaves the liver by the **hepatic veins,** which open into the inferior vena cava; in this way the nitrogenous part of the food, the salts and water reach the heart, to be pumped to every part of the body.

Peptones are poisonous if injected into the blood; they are not found in it. The nitrogenous material in the blood is proteid. On their way from the inside of the digestive canal through to the inside of the bloodvessels, the peptones seem to be converted once more into proteids.

The **Lacteals** are small vessels, into which pass the minute particles of the emulsified fats. They have, when full, a milky appearance. They unite into larger vessels, and ultimately form a trunk known as the **Thoracic Duct,** which, passing up the thorax close to the spinal column, opens into the superior vena cava, and pours the fatty portion of the food into the blood-stream.

We have seen that the food, having undergone remarkable

changes in the digestive tract, passes into the blood-stream, and is thus distributed to the rest of the body.

The small intestine opens into a wider tube, the **Large Intestine**, at the lower part of the abdomen on the right side. This portion of the digestive canal is much wider and less coiled than the small intestine; it is divided into four parts, the first of which, the **Ascending Colon**, passes upwards on the right-hand side of the abdomen to the liver, then bends to the left, coursing across the body to the stomach; this horizontal part is the **Transverse Colon**; on the left side of the abdomen, close to the spleen and stomach, the transverse colon bends downwards and becomes the **Descending Colon**, which passes down on the left side of the abdomen to the pelvis. The part of the large intestine occupying the pelvis is known as the **Rectum**, and the canal ends by an opening, the **Anus**.

A certain amount of absorption takes place in the large intestine, but much less than higher up in the digestive tract. The contents of the larger bowel are more solid than in the small intestine, and consist largely of the parts of the food which cannot be digested, and which pass away from the body as the fæces.

Excretion.

The food, changed by digestion, is absorbed, and carried by the blood-stream to the tissues. Here the various constituents of the food are converted into bone, muscle, fat, etc. During the activities of the body, these complex bodies are broken up into simpler substances, the most important of which are water, carbon dioxide, mineral matters, and **urea**—a nitrogen-containing substance which is the result of decomposition of the nitrogenous parts of the body. Nitrogen enters the body as proteid, and leaves it as urea.

These waste matters are picked up from the tissues by the blood, and are carried away to the three main channels of outlet:

1. The **Lungs** get rid of most of the carbon dioxide and a large quantity of water. This action of the lungs has already been studied.

2. The **Skin** serves as a channel for the discharge of a small quantity of mineral matters (salts), a little carbon dioxide, and a variable quantity of water.

3. The **Kidneys** discharge the urea, most of the mineral matter (salts), and a large quantity of water.

There is thus a division of labour amongst the excretory organs in health. In disease of any one of them, extra work is thrown upon the other two, and the body in general suffers.

The **Skin** is composed of two layers: the **epidermis**, or cuticle, and the **cutis vera**, or true skin. The epidermis is made up of numbers of layers of cells, the deepest ones being soft and columnar in shape, and the more superficial ones horny, hard, and flattened into scales. The cutis is composed of dense tissue, and contains nerves, bloodvessels, and glands.

The **Hair** and **Nails** are derived from the epidermis, and are simply modifications of it.

The **Glands** of the skin are of two kinds: the **Sebaceous Glands** and the **Sweat Glands**. **Sebaceous Glands** are minute sac-like bodies, which secrete an oily material. They open close to the roots of the hairs; their secretion nourishes the hairs and keeps the skin soft and flexible.

The **Sweat Glands** are found over the whole skin, but are most numerous on the palm of the hand and the sole of the foot. Each consists of a coiled-up tube, lying in the deeper part of the true skin, and opening by means of a corkscrew-like channel on to the surface of the epidermis. From these openings, which are called the **Pores of the Skin**, is continually passing a certain amount of water vapour. This may pass straight away into the air, when it is called **Insensible Perspiration**; or some of it may remain on the surface of the body condensed to drops of liquid; this is **Sensible Perspiration**. The sweat, or perspiration, consists of about ninety-nine parts of water to one part of solid matter (salts of different kinds). The amount of sweat varies greatly according to the amount of water taken into the system and the amount which leaves the body by the lungs and kidneys; it has been calculated to average about 2 pounds in twenty-four hours for an adult.

The following Table shows the Processes of Digestion, Absorption, and Excretion.

Non-diffusible Food-Stuff.	*Diffusible Product of Digestion.*	*Digestive Organ and Fluid concerned.*	*Chief Uses.*	*Mode of leaving the Body.*
1. **Proteid.** *Sources:* Meat, fish, eggs (white), cheese (casein).	Peptone.	1. Stomach, gastric juice (pepsin). 2. Small intestine, pancreatic juice (trypsin), aided by bile.	Forms new tissue. Repairs waste. Provides some heat and force.	1. By the **kidneys**, as *urea* and *water*. 2. By the **lungs**, as *water* and *carbon dioxide*. 3. By the **skin**, as *water*.
2. **Carbohydrates.** *Sources:* Starch of bread, potato, etc.; cane-sugar.	Sugar of the grape-sugar and malt-sugar class.	1. Mouth, saliva (ptyalin). 2. Small intestine, pancreatic juice (amylopsin).	Form fat. Provide heat and force.	1. By the **kidneys, lungs,** and **skin**, as *water*. 2. By the **lungs**, as *carbon dioxide*.
3. **Fats.** *Sources:* Butter, cream, fat of meat; animal and vegetable oils.	Emulsion.	Small intestine, pancreatic juice and bile.	Provide heat and force.	The same as carbohydrates.

By evaporation of the sweat from the surface the body is cooled and the temperature is regulated.

The **Kidneys**, two in number, are situated close to the spinal column in the upper part of the abdomen. Each is about 4 inches long, and 4½ ounces in weight. They have the power of abstracting from the blood that reaches them by the **renal arteries** the urea and most of the mineral salts which are formed during the body-activity. Between 2 and 3 pints of water are discharged daily by the kidneys. The excretion of the kidneys —**Urine**—passes down from each of these organs by a tube—the **Ureter**—opening below into the **Bladder**, which is situated in the lowest part of the abdomen.

THE HUMAN BODY. A Short Account of the Anatomical Arrangement and Physiological Functions of the various Organs of the Human Body. By Owen Lancaster, M.R.C.S. Illustrated by a Movable Figure showing the exact position and relative size of the Organs of the Body. Price 2s. net. (Allman & Son, Ltd., 67, New Oxford St., London, W.C.)

CHAPTER V.

THE NERVOUS SYSTEM AND THE SENSUAL ORGANS.

Central Nervous System—Nerves—Impulses—White and Grey Matter—The Membranes covering the Central Nervous System. The *Brain:* Cerebrum—Motor and Sensory Centres—The Cerebellum—Pons—Bulb. The *Spinal Cord:* The Spinal Nerves—Structure of a Nerve—Medullated—Non-medullated. The *Sympathetic System:* Terminations of Motor Fibres—The Course of a Nervous Impulse. The *Sensual Organs:* Touch—Taste—Smell—Hearing and the Ear—Vision and the Eye.

The Nervous System.

The nervous system regulates and controls the whole of the rest of the body. No part can fulfil its functions unless its nerve-supply is in working order.

The **Nervous System** consists of a **Central Portion**, the brain and spinal cord, from which branches, the **Nerves**, pass away to every part of the body. Nervous impulses pass along a nerve in one of two directions:

1. **From the Brain** to distant parts, when they are called **Efferent** impulses (going out from).

2. **To the Brain** from distant parts, when they are called **Afferent** impulses (going towards).

Nerves transmitting efferent impulses are sometimes called **Motor** nerves, because they go to muscles and produce motion. Nerves transmitting afferent impulses are called **Sensory**, because they convey to the brain impressions from organs of sense, which become sensations.

Besides the brain, spinal cord, and nerves, the nervous system comprises bodies known as **Ganglia**, which are connected with the nerves in various parts; they look like swellings on the nerve, and have to do with the control and regulation of nervous impulses.

The whole nervous system consists of thread-like **Fibres** and of **Cells**. Each fibre is a prolongation from a cell. Fibres are found in the nerves, and, like telegraph-wires, convey impulses

to or from the central part along the nerve trunk. They also compose the larger part of the central portion of the nervous system, where their white, glistening appearance gives this part the name of **White Matter**. The cells, on the other hand, are rarely found in nerves, except at their terminations, but are confined chiefly to the brain, spinal cord, and ganglia. They make up what is known as **Grey Matter**.

The **Central Nervous System** is contained within the skull and the neural canal of the vertebral column. It consists of two halves, the right and the left, united by white and grey substance passing from one side to the other. It is surrounded both within the skull and also within the neural canal by three membranes, between which are spaces filled with clear fluid.

The outermost of these membranes is the firm, tough **Dura Mater**, next to the bone; then comes the delicate **Arachnoid**; and, thirdly, closely applied to the surface of the brain and cord, and dipping into all their hollows and irregularities, is the **Pia Mater**, full of bloodvessels, to nourish the nervous tissue.

The **Brain** is situated in the skull. It is the organ in which the processes of bodily and mental activity originate, and which receives and interprets all impressions from the organs of sensation. It weighs about 40 ounces, and is divided into **Cerebrum**, or large brain; **Cerebellum**, or small brain; **Pons**, or bridge; and **Medulla Oblongata**, or **Bulb**, which is the connecting-link between the brain and spinal cord.

The **Cerebrum** occupies the fore and upper parts of the skull; it is divided by a deep longitudinal furrow into two halves—the **Cerebral Hemispheres**. Each hemisphere is thrown into folds, the **Convolutions**; this gives the cerebrum somewhat the appearance of a large shelled walnut. If we cut into the hemispheres, we find them to be composed of a layer of grey matter (cells) on the outside, covering the white matter (fibres) within.

This grey matter is known as the **Cortex** (bark). It has been found that the cells in certain parts of the cortex are associated with movements of certain parts of the body, and that disease of these parts of the cortex causes loss of power in the parts of the body to which they correspond. These portions of the cortex are known as the cortical **Motor Centres**; they are grouped

about a fissure at the side of each hemisphere. It has also been found that certain other parts of the cortex correspond to the different sense organs. Thus, one part of the cortex is connected with seeing, another with hearing, and disease of these parts may produce blindness or deafness. These are the **Sensory Centres.**

The **Cerebellum** is much smaller than the cerebrum, and occupies the back and lower part of the skull. It is chiefly concerned in keeping up the balance of the body and controlling the voluntary muscles. The cerebellum consists of grey and white matter, and is connected by tracts of nerve fibres with the cerebrum above and the cord below.

The **Pons**, or mid-brain, is a connecting-link between the two cerebral hemispheres above and the bulb below. It contains masses of grey matter, from which some important nerves originate.

The **Bulb**, or medulla oblongata, is a small expansion between the pons and the cord; it lies in the lowest part of the cavity of the skull, and is continued down the neural canal as the spinal cord. It contains masses of grey matter, from which nerves arise; amongst others, those which pass down to supply the heart and lungs. The bulb thus may be said to contain the centres for the vital processes of circulation and respiration; injury to the bulb has often produced sudden death by stoppage of one or both of these vital processes.

The **Spinal Cord** occupies the neural canal, and is bounded in front by the column of vertebral bodies, being covered in at the sides and back by the neural arches. It is about 18 inches long, and is divided by deep fissures in front and behind into two halves.

The **Grey Matter** of the cord (cells) is situated in the interior, not outside, as in the brain; and it is surrounded by **White Matter.** If the cord is cut across, it is seen to be rounded in section, and the grey matter is arranged in the form of two crescents placed back to back. From cells in the horns of these crescents, nerve fibres pass out of the cord to form the **Spinal Nerves.** Each spinal nerve has two **roots—anterior** and **posterior**—coming from the anterior and posterior horns respectively of the grey crescent in the cord. The anterior root

ontains the **motor**, and the posterior root the **sensory**, fibres. O the posterior root is a small swelling, the **ganglion** of the sterior root, containing cells which preside over the nutrition othe fibres in the posterior root. The two roots join to form a ixed motor and sensory nerve, which, passing out from the ural canal, enters the tissues beyond. A pair of spinal nerves orresponds to each vertebra.

A **Nerve** consists of bundles of fibres wrapped together by brous tissue into a rounded cord. Each fibre consists of the llowing parts:

1. A central thread-like structure, the **Axis-Cylinder**, which the essential part of the fibre, and is a prolongation from a cell i some part of the brain or spinal cord or sense organ. The erve fibre depends for its life upon the connection between the ll and the axis-cylinder, and if this connection is broken the bre degenerates and dies.

2. A **Sheath.** Nerve fibres are classed according to the kind f sheath they possess.

(α) **Medullated nerve fibres** are white and thick, being surounded by a fatty covering inside their delicate sheath.

(β) **Non-medullated fibres** do not possess this fatty covering; ney are finer than medullated fibres, and lack their white and listening appearance.

A mixed nerve, such as a spinal nerve, contains some of both inds of fibres. Medullated fibres may be motor or sensory; on-medullated fibres are destined principally for the supply of he involuntary muscle of bloodvessels, and for internal organs.

Twelve pairs of nerves are given off from the brain itself, and re known as the **Cranial Nerves.** They leave the skull by arious apertures in the bones, and are of the same structure as he spinal nerves. The organs of sight, hearing, taste, and smell re connected by means of certain cranial nerves with the brain.

The Sympathetic System is really formed by offshoots from he spinal nerves. It is a chain of **ganglia**, connected by nerve ords, lying, something like a knotted string, on each side of the ertebral column.

Each ganglion consists of a mass of cells. It communicates with the neighbouring spinal nerve by a branch consisting of non-

A. Cerebrum, or brain proper.
B. Cerebellum, or little brain.
C. Spinal cord.
1. Olfactory (nerve of smell).
2. Optic (nerve of sight).
3. Motor oculi.
4. Pathetic nerve.
5. Trifacial (trigeminus nerve.
   (*a*) Small root.
   (*b*) Large root.
6. Abducens.
7. Facial.
8. Auditory.
9. Glosso-pharyngeal.
10. Vagus or pneumogastric.
11. Spinal accessory.
12. Hypoglossal.
13. Corpora albicantia.
14. Infundibulum.
15. Pons varolii.
16. Medulla oblongata.
17. Anterior lobes of the brain.
18. Middle lobes of the brain.
19. Posterior lobes of the brain.
20. Internal carotid arteries.
21. Basilar artery.
22. Vertebral arteries.
23. Spinal nerves.
   (*a*) Anterior roots (motor roots).
   (*b*) Posterior roots (sensory roots).
24. Ganglia of the spinal nerves attached to posterior roots.
25. Cone of spinal cord (where spinal cord becomes smaller).
26. Filum terminale (slender filament in which spinal cord ends).
27. Cauda equina (roots of origin of the lowest spinal nerves).
28. Dura mater (protecting sheath of spinal cord).
29. Ligamentum denticulatum (band dividing anterior from posterior root of spinal nerve).

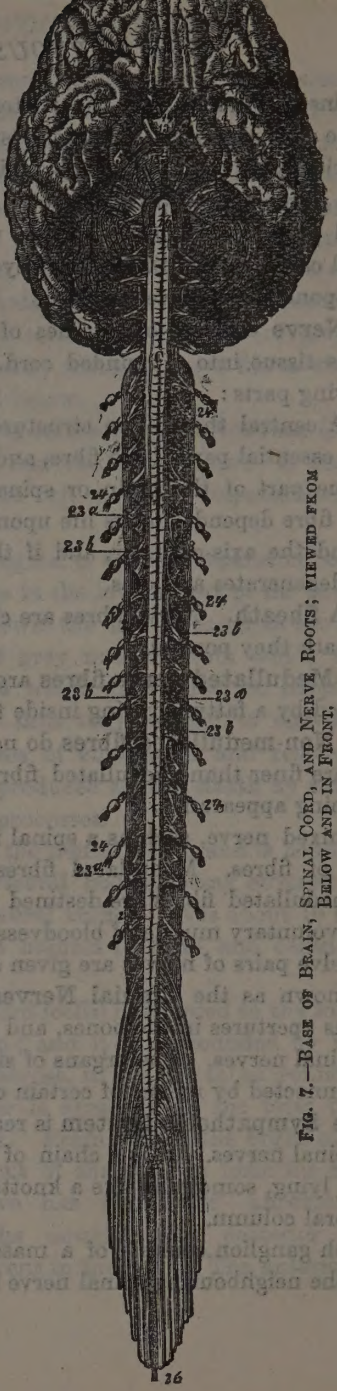


FIG. 7.—BASE OF BRAIN, SPINAL CORD, AND NERVE ROOTS; VIEWED FROM BELOW AND IN FRONT.

medullated fibres. From the sympathetic ganglia are given off numerous nerves of the non-medullated class, which pass to the internal organs and bloodvessels.

Terminations of Nerve Fibres.—The **Motor Fibres** of a nerve end in muscles. Each muscle fibre has a very fine nerve fibre passing to it, and ending upon it by expanding into a sort of plate, which is closely applied to the surface of the muscle fibre. This is known as an **End-Plate.** Through the end-plate the nervous impulse passes to the muscle fibre, causing a contraction.

Sensory Fibres end, or rather begin, in different ways, according to the sensation which they convey. These will be considered with the sense organs.

The Course of a Nervous Impulse.—In order to understand the connections between different parts of the nervous system, let us follow the course of events occurring whenever a voluntary action is performed. Let us take, for example, the act of saluting a friend in the street. Rays of light pass from every visible part of the friend into our eyes, and fall upon the back of the eyeballs. Here they set up chemical changes which produce an effect upon the sensory nerve apparatus in this part. By this means sensory impulses are started, travel along the optic nerves to the back part of the brain, and arouse there, in the cortical cells where the path of the impulses ends, a set of changes, whereby we become conscious that we see our friend before us, and wish to salute him. This part of the process is the **Stimulus,** or **Excitation.**

The instant that a desire arises to show our friend that we recognise him, an impulse passes along from the **centre for seeing,** which has just been excited, through fibres in the white matter of the brain, to the cells in the **motor centres** of the cortex, which, as we saw, were grouped round a fissure on each side of the cerebrum. Changes are set up in these cells, which give rise to a **Motor Impulse,** or message to the muscles. This impulse or message passes from the cortex, through the white matter of the hemispheres and pons, into the bulb. Here the nerve fibres conveying the motor impulses cross over to the other side, and pass down in the white matter of the cord, to end in, or near, cells in the anterior horns of the grey crescents. Thus we

see that the right half of the brain has to do with movements of the left half of the body, and *vice versâ*, the motor paths crossing one another in the bulb.

These fibres, having conveyed the message as far as the nerve cells in the grey matter of the cord, end; but the message is passed on by the cells to fresh fibres, passing out from the cord by the anterior nerve roots. Thus the message is conveyed direct to the muscles, where it produces in them **Contractions.** The arm muscles produce by their contractions the movements of raising the hat, stretching out the hand, etc.; the contractions of the muscles of the larynx, mouth, lips, and tongue give rise to speech, and so forth.

Every voluntary action is complex like this, but the nervous impulse travels with such lightning rapidity that we are not aware of the process as it takes place.

The Sense Organs.

1. Touch.—In the skin are numerous minute projections, called **Papillæ**, which contain rounded masses, known as **Tactile Corpuscles.** In these the finest nerve fibres are found, which convey impressions from the skin to the central nervous system. The tactile corpuscles are most numerous in the tips of the fingers and tongue, and are least numerous in the skin of the back.

2. Taste.—This special sense is located in the tongue and palate.

The tongue bears on its surface papillæ, or elevations, of three kinds:

(i.) The **Circumvallate** papillæ, situated at the back of the tongue, are easily seen as rounded elevations, surrounded by a groove and ridge.

(ii.) The **Conical** papillæ cover most of the surface.

(iii.) The **Fungiform** papillæ are scattered here and there over the surface. In certain diseases, notably in scarlet fever, these show up bright red on a white furred tongue, and give the appearance known as 'strawberry tongue.'

In the walls of the fungiform and circumvallate papillæ, and

in the membrane covering the soft palate, are found groups of cells known as **Taste-buds.** Each taste-bud contains elongated cells. One end of the cell, drawn out to a fine point, projects on the surface of the papilla; the other end is connected with a nerve fibre. Fibres from many taste-buds unite and form a part of the glosso-pharyngeal, one of the cranial nerves.

Tasty substances are dissolved in the mouth by the saliva, and come into contact with the cells of the taste-buds; impressions of taste are conveyed to the brain by the glosso-pharyngeal nerve.

3. **Smell.**—The inside of the nose is lined with a mucous membrane, which contains certain long tapering cells, spindle-shaped, with their free ends projecting above the level of the mucous membrane. The deep ends of these cells are connected with a network of fine nerve fibres, which unite together to form the **Olfactory Nerves** and convey impressions of smell to the brain.

4. **Hearing.**—The **Ear** consists of three parts: **External, Middle,** and **Internal.**

The **External Ear,** or **Pinna,** consists of cartilage covered by skin. It collects the sound and conveys it to the inner parts of the ear, but is not necessary for hearing. Leading inwards from the external ear is a passage, the **External Auditory Canal,** composed partly of cartilage and partly of bone. The whole canal measures about 1¼ inches in length. Rather less than half of it is formed by a prolongation inwards of the cartilaginous pinna. The canal then enters the bone. It is closed at its inner end by the **Tympanic Membrane,** a thin translucent structure, dividing the external from the middle ear.

The **Middle Ear,** or **Tympanum** (or drum), is a small irregular cavity in the bone. At the bottom of it is an opening which leads into the **Eustachian Tube**; this opens into the back of the throat, and thus the tympanum communicates with the outer air. The lining membrane of the throat passes up the Eustachian tube and lines the walls of the tympanum.

Across the cavity of the tympanum there stretches a chain of three tiny bones: the **Malleus** (hammer), fixed to the tympanic membrane; the **Stapes** (stirrup), whose base closes an opening, the **Fenestra Ovalis,** in the upper part of the tympanum; and

the **Incus** (anvil), lying between the two others and forming joints with them. The tympanum is supplied with numerous nerves and blood-vessels.

The **Internal Ear**, or **Labyrinth**, is the essential part of the organ of hearing, and consists of a membranous tube contained within a bony tube hollowed out in the skull. It is called the labyrinth because it is twisted and coiled in a very complicated manner; it is lined with cells, and filled with a fluid called **Endolymph**.

The internal ear comes into relation with the middle ear in two places, the **Fenestra Ovalis**, which is an opening in the bony wall of the tympanum, closed by membrane and by the base of the stirrup-bone, and the **Fenestra Rotunda**, a similar opening lying below the fenestra ovalis, and also closed by a membrane. The endolymph of the internal ear is kept from flowing into the middle ear by means of these closing membranes.

The internal ear consists of the **Vestibule**, into which open the **Cochlea** and the **Semicircular Canals**.

The **Semicircular Canals** are three in number, and are arranged at right angles to one another, in the three dimensions of space.

The **Cochlea** is a tube coiled spirally, like a snail-shell. A flat membrane stretches from one side of this tube partly across it, and takes the spiral form of the tube. This **Basilar Membrane** bears upon it the **Organ of Corti**, in which are found numerous elongated cells. The ends of the cells which project into the cavity of the cochlea are furnished with stiff hair-like projections, and are called **Hair Cells**. The other ends of these cells, applied to the basilar membrane, are connected with nerve fibres which unite to form a nerve passing down the central part of the cochlea, and joining the **Auditory Nerve**, which enters the brain.

How Sounds are Heard.—A sound is the result of vibrations in the air. When one body strikes another so as to produce a sound, waves are set up in the air and reach the external ear, pass down the external auditory meatus, and strike against the tympanic membrane. This is set into vibration; the motion is

conducted along the chain of bones, and is communicated through the fenestra ovalis to the endolymph in the internal ear. The endolymph is set into vibration, and its movements within the cochlea cause alterations in the tension of the basilar membrane and changes in the hair cells. These changes create nervous impulses in the nerves connected with the hair cells,

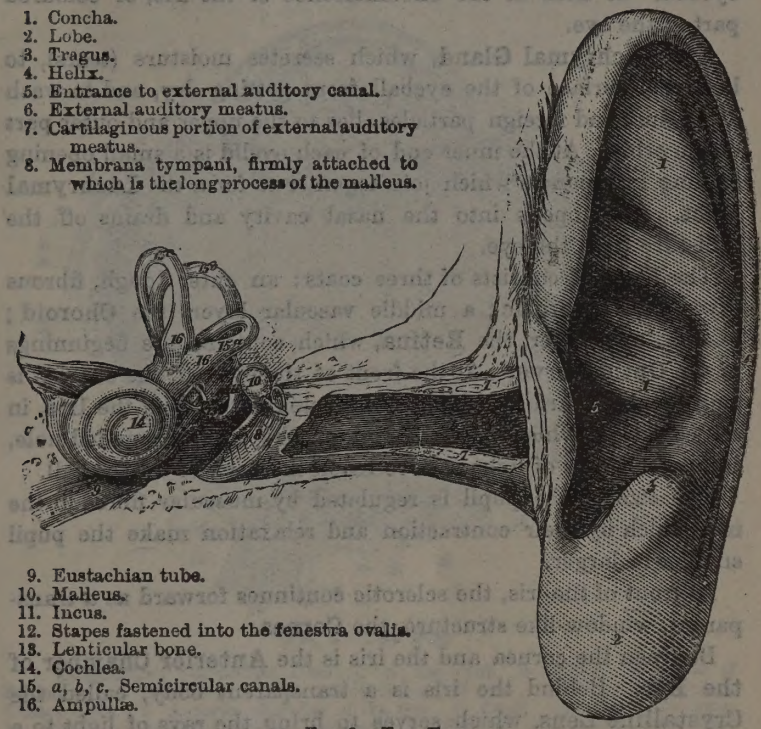

1. Concha.
2. Lobe.
3. Tragus.
4. Helix.
5. Entrance to external auditory canal.
6. External auditory meatus.
7. Cartilaginous portion of external auditory meatus.
8. Membrana tympani, firmly attached to which is the long process of the malleus.
9. Eustachian tube.
10. Malleus.
11. Incus.
12. Stapes fastened into the fenestra ovalis.
13. Lenticular bone.
14. Cochlea.
15. a, b, c. Semicircular canals.
16. Ampullæ.

FIG. 8.—THE EAR.

which are conveyed to the brain by the auditory nerve as impressions of sound.

Different parts of the basilar membrane and of the organ of Corti respond to vibrations caused by different tones; there is a special part for every tone which the ear is capable of appreciating; and the movements of the endolymph set that particular part of the membrane vibrating that corresponds to the tone which is being produced at the time.

5. **Sight.**—The **Eye** is lodged in a bony cavity, the **Orbit**, which protects and covers it in except in front. Here it is covered by the **Eyelids**, fringed with hairs, the **Eyelashes**.

The **Eyelids** are lined with a sensitive mucous membrane, the **Conjunctiva**, which passes from them on to the front of the eyeball. It ends at the circumference of the iris, or coloured part of the eye.

The **Lachrymal Gland**, which secretes moisture (tears), to keep the surface of the eyeball from getting dry, and to wash away dust and foreign particles, lies to the upper and outer part of the orbit. At the inner end of each eyelid is a small opening leading into canals which join together to form the **Lachrymal Duct**. This opens into the nasal cavity and drains off the moisture from the eye.

The **Eyeball** consists of three coats: an outer tough, fibrous layer, the **Sclerotic**; a middle vascular layer, the **Choroid**; and an inner layer, the **Retina**, which contains the beginnings of the **Optic Nerve**. At the front of the eyeball, the choroid is continued forward in the form of a coloured curtain, the **Iris**, in the centre of which is the **Pupil of the Eye**, a rounded hole, into which rays of light pass to reach the back of the eyeball.

The size of the pupil is regulated by muscular fibres in the iris, which by their contraction and relaxation make the pupil smaller or larger.

In front of the iris, the sclerotic continues forward as a transparent, window-like structure, the **Cornea**.

Between the cornea and the iris is the **Anterior Chamber of the Eye**. Behind the iris is a transparent body, called the **Crystalline Lens**, which serves to bring the rays of light to a focus upon the retina.

The rest of the inside of the eyeball is occupied by a transparent, jelly-like fluid, the **Vitreous Humour**; and the part behind the lens is called the **Posterior Chamber**.

The anterior chamber is filled with a clear, watery fluid, the **Aqueous Humour**.

A black or dark appearance is given to the inside of the eye, owing to the presence of a layer of cells containing **Pigment**, or colouring matter, lying between the choroid and the retina.

The **Retina** is the most important of the coats of the eyeball, for in it expand the fibres of the optic nerve, through which impressions of sight are conveyed to the brain. The retina is composed of different layers of cells. The outermost layer, lying next to the choroid, and separated from it by the layer of pigment cells and a fine membrane, is called the **Layer of Rods**

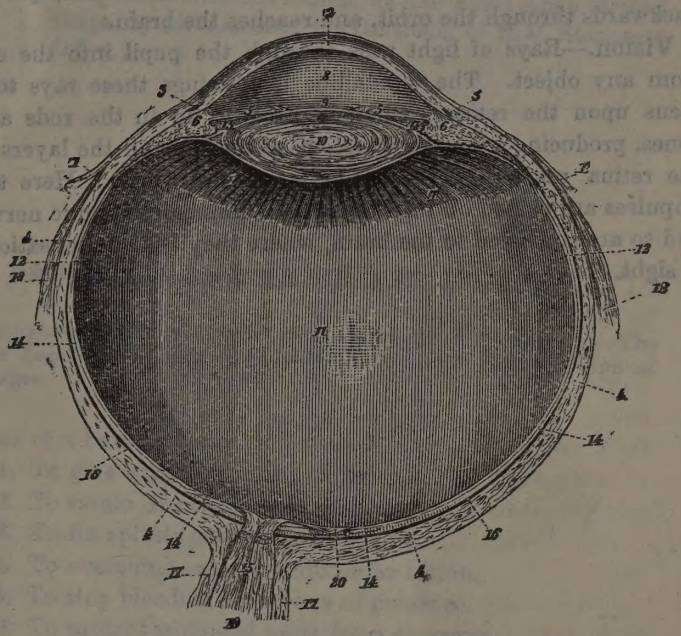


FIG. 9.—THE EYE.

1. Conjunctiva (outermost covering of the eye). 2. Cornea. 3. Canal of Schlemm. 4. Sclerotic. 5. Iris (coloured part of eye). 6. Ciliary muscle. 7. Ciliary body. 8. Anterior chamber of the eye. 9. Pupil. 10. Crystalline lens. 11. Cavity occupied by vitreous humour. 12. Hyaloid, or vitreous membrane. 13. Posterior chamber of the eye. 14. Retina, or nervous tunic. 15. Optic nerve. 16. Choroid tunic. 17. Cellular covering of optic nerve. 18. Eye muscles. 19. Central artery of the retina. 20. Yellow spot.

and Cones. These are cells shaped as their names indicate, some elongated and others conical in form, packed side by side. From their ends pass fine fibres, which expand into granular rounded bodies, forming the **Outer Nuclear Layer.** Fibres from these form a branching network. Next comes another layer of granular bodies, the **Inner Nuclear Layer**, which in

their turn give off fibres interlacing with each other and forming a network. Close to the inner surface of the retina, next to the vitreous humour, is a layer of large **Nerve Cells**, which send processes into the network of the inner nuclear layer, and which are connected by fine nerve fibres with the **Optic Nerve**. This leaves the eyeball at about the middle of the retina, passes backwards through the orbit, and reaches the brain.

Vision.—Rays of light pass through the pupil into the eye from any object. The crystalline lens brings these rays to a focus upon the retina. Changes are set up in the rods and cones, producing impulses which pass through all the layers of the retina until they reach the large nerve cells. Here the impulses are passed on into the small fibres of the optic nerve, and so are conveyed to the brain, where they become sensations of sight.

HOME NURSING. By E. MARGERY HOMERSHAM, Member of the General Council of the Royal British Nurses' Association. Foolscap 8vo., 96 pages, paper covers, price 3d. (ALLMAN & SON, LTD., 67, New Oxford St., London, W.C.)

NOTE.—**Application of the Triangular Bandage.**—The use of the Triangular Bandage as laid down in the following chapter is reprinted from the Manual for the Royal Army Medical Corps, by permission of the Controller of H.M. Stationery Office.

PART II.

CHAPTER I.

BANDAGES AND THEIR APPLICATION.

The Triangular Bandage—Description—Methods of Application—The Roller Bandage—General Rules—Methods of Application—Special Bandages.

THE uses of a bandage are:

1. To give support to injured parts.
2. To retain dressings in their places.
3. To fix splints and other apparatus.
4. To overcome excessive muscular action.
5. To stop bleeding by means of pressure.
6. To protect wounded parts from exposure.

Bandages may be divided into:

1. Triangular.
2. Roller.
3. Bandages of special form.

1. The Triangular Bandage and its Application.

To make the Triangular Bandage.—Take a piece of linen or unbleached calico, not less than 38 inches square; fold it diagonally, and cut it along the fold. This will give two bandages.

The named parts of the bandage are: The lower border—the

base of the triangle, BC; the side-borders—the two sides of the triangle, AB, AC; the point—the apex of the triangle, A; the two ends—the ends of the triangle, B and C.

To fold the Bandage for Stowage.—First fold it perpendicularly down the centre, placing the right end on the left; then bring the ends thus folded and the point to the centre of the lower border, thus forming a square; now fold in half from right to left; and, lastly, fold in half from above downwards twice. This will give a packet 7 by $3\frac{1}{2}$ inches, which may be pinned to prevent unrolling.

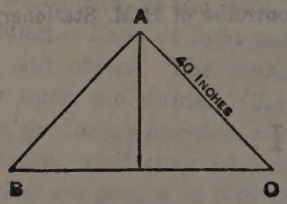


FIG. 10.—THE TRIANGULAR BANDAGE.

The Advantage of the Triangular Bandage is that it can be easily made out of a large handkerchief, and it is therefore well suited for an emergency bandage. Its method of application can be easily learnt. Temporary dressings can be applied better by it than by the roller bandage; and it can be used for almost every purpose for which a bandage is required—viz., to retain dressings, to fix splints, to exercise pressure, as an extemporized tourniquet, and as a sling.

The Modes in which the Triangular Bandage may be used.

The bandage is applied as: (*a*) a whole cloth; (*b*) broad fold; or (*c*) narrow fold. The whole cloth is the bandage spread out to its full extent. The broad fold is made from the whole cloth by carrying the point to the centre of the lower border, and then folding the bandage again in the same direction. The narrow fold is made by folding the broad fold once lengthwise.

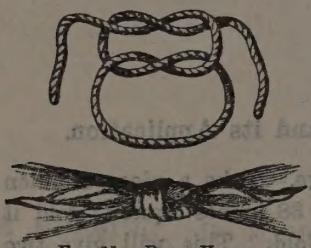


FIG. 11.—REEF KNOT.

Reef Knot.—In every case where a knot has been tied, a reef knot will be used, the formation of which is best explained by the accompanying diagrams showing how to make it.

To Bandage Top of Head.—Take a whole cloth, lay the centre on the top of the head, the lower border lying along the forehead just above the eyebrows; fold in the edge, pass the ends round behind, leaving the ears free; cross below the occipital protuberance over the point of the bandage; bring the ends to the front again, and knot off on the centre of the forehead. Place the hand on the top of the head to steady the dressing, draw the point down to tighten and fit the bandage to the head, then turn it up and pin off on the top.

Side of Head.—Place the centre of a narrow fold over the dressing, pass the ends horizontally round the head, cross and knot off over the dressing.

FIG. 12.—GREATER ARM SLING.

Both Eyes.—Place the centre of a broad fold between the eyes, carry the ends backwards, cross and knot off in front.

One Eye.—Place the centre of a narrow fold over the injured eye, pass one end obliquely upwards over the forehead, the other downwards across the ear; cross below the bump at back of head, and knot off above the eyebrow on the injured side.

Chin and Side of Face.—Place the centre of a narrow fold under the chin, pass the ends upwards, and knot off over the top of head, tucking in the ends.

Neck.—Place the centre of a narrow fold over the dressing, cross the ends, bring back and knot off over the wound.

Chest.—Apply the centre of a broad fold over the dressing, pass the ends round, and knot off on the other side, leaving a long end; take a narrow fold, tie to long end, bring it over the shoulder, and pin off to broad fold over the dressing.

Abdomen.—Place the centre of a broad fold over the wound, and knot off on the side.

To Apply the Greater Arm Sling.—Take a whole cloth, throw one end over the shoulder on the sound side, carry it round

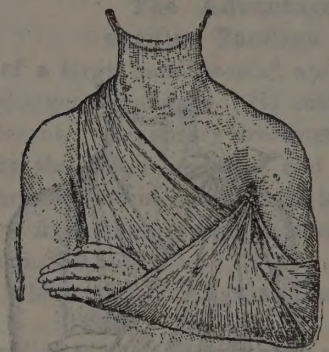


FIG. 13.—ARM SLING FOR FRACTURED COLLAR BONE (CLAVICLE).

the neck so as to lie over the opposite shoulder; place the point behind the elbow of the injured arm, allowing the other end to fall down in front of the patient; bend the injured arm carefully, and place it across the chest on the middle of the bandage, thumb pointing towards the chin; bring up the lower end in front of the forearm, and knot off to the end lying over the shoulder on the injured side; draw the point forward round the elbow and pin off.

In Broken Collar Bone.—There is one exception to this method of applying the greater arm sling, viz., in fracture of

the clavicle, where it is not advisable to allow anything to press on the injured bone. To avoid this, the lower end, which is brought up in front of the forearm, should be passed between the arm and the side of the injured shoulder, and knotted off to the upper end behind the neck.

Fractured Clavicle.—This bandage may be also used to secure the arm temporarily in cases of fractured clavicle. Having placed a pad in the armpit, apply the centre of a narrow-fold bandage to the outer surface of the arm of the injured side; carry the front end horizontally across the chest; bring the back end forwards between the arm and chest, over the upper margin

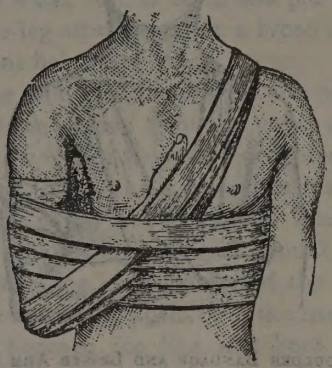


FIG. 14.—BANDAGE FOR FRACTURED CLAVICLE.

of front part of bandage, then up through the loop formed; carry backwards round chest, exercising steady traction, so as to draw the arm backwards; then secure the two ends on the opposite side of the chest. The arm-sling depicted in Fig. 13 can then be applied. An ordinary roller bandage may be used, taking care to place a pad between the upper arm and the chest, to draw the upper arm well back, and to support the elbow, as shown in Fig. 14.

To Apply the Lesser Arm Sling.—Take a broad fold, place one end over the shoulder on the sound side, carry it round

the point over the back of the hand to the waist, pass the ends back of the neck so as to lie over the opposite shoulder, allowing the other end to fall down, bend the arm carefully and place the wrist across the middle of the bandage with the hand a little higher than the elbow, bring up the lower end, and knot off to the upper end over the shoulder on the injured side.

To Bandage the Shoulder.—Lay the centre of a whole cloth on the top of the shoulder, point upwards, the lower border lying across the middle of the arm. Fold in the lower border, carry the ends round the arm, cross them, and knot off on the outer

SHOULDER BANDAGE AND LESSER ARM SLING.

side. Apply the lesser arm sling, draw the point of the first bandage under the arm sling, fold it back on itself, and pin off over the shoulder.

Elbow.—Place the centre of a whole cloth over the back of the bent elbow, point upwards, turn in the lower border, pass the ends round the forearm, cross them in front, pass up round the arm, cross behind, and knot off in front. Tighten the bandage by drawing on the point, which is then brought down and pinned off. Apply greater arm sling.

Hand.—Take a whole cloth, place the hand palm downward on the centre of the bandage, fingers towards the point, bring

round the wrist, crossing them over the point, which is then folded towards the fingers, and covered by another turn of the bandage round the wrist. Knot off the ends in front of the wrist.

Or a figure-of-eight bandage, narrow fold, may be used. Place centre of bandage over dressing, bring ends round to opposite side of hand, cross and take two or three turns round the wrist and knot off. Apply the greater arm sling.

Hip.—Take a narrow fold, apply it round the waist and knot off in front, then take a whole cloth, place the centre over the hip, point upwards, the lower border—which should be folded in—lying across the thigh; pass the ends round the thigh, and knot off on the outer side. Draw the point upwards beneath the bandage round the waist, turn it down and pin off.

Knee.—Keep the leg straight, apply a broad fold, cross behind, and knot off in front below kneecap.

Foot.—Place the sole of the foot on the centre of a whole cloth, toes towards the point; turn the point upwards over the instep, take one of the ends in each hand close up to the foot; bring them forward, cross them over the instep covering the point. Draw the point up to tighten the bandage, and fold it towards the toes. Carry the ends back round the ankle, cross them behind, catching the lower border of the bandage. Bring the ends forward, cross them again over the instep, covering the point, carry them beneath the foot, and knot off on the inner side.

Other Part of Limbs.—When applied to any other part of the limbs, a broad fold is used, the centre of the bandage being placed over the dressing, the ends passed round the limb, and knotted off over the wounds.

Perinæum and Lower Part of Abdomen.—Take a whole cloth, lower border uppermost, pass the ends round the waist immediately above the hips, and knot off behind, leaving one long end; pass the point between the legs, draw it upwards, and knot off to the long end behind. Another method: Apply a narrow-fold bandage round the waist; pass the end over a second bandage, similarly folded, beneath the waist bandage at the centre of the back, fold over and secure with safety-pin;

bring the other end forward between the thighs, up to the waist bandage in front, pass beneath, turn over and secure with safety-pin. This forms a modified T bandage.

Wound in the Groin.—Apply the centre of the bandage, folded narrow, to the back of the thigh just below the buttock, bring the ends forwards, cross them over the groin, carry them back above the hips, cross them behind, bring them forward, and tie off in front.

For a Limb torn off.—Lay the bandage under the limb with the lower border upwards, draw the point well over the stump, bring the ends forwards after crossing them behind, and tie off in front. Now draw the point over the knot and pin it.

The Triangular Bandage for Fractures.—1. *For Fracture of the Lower Jaw.*—There are two methods:

A. Apply the centre of a bandage folded narrow to the point of the chin, carry the ends upwards, one on each side, pass one end over the top of the head till it meets the other end just above the ear, twist the two ends over each other, carry one in front of the forehead and the other behind the back of the head, and tie off above the opposite ear.

B. Take a bandage folded narrow, place the middle of it over the point of the chin, carry the two ends upwards, and tie them in a half-knot just behind the vertex. Now take a second bandage folded narrow, place the centre of it under the lower lip, pass the ends backwards, tie them in a half-knot at the level of the occipital protuberance, then tie the two ends of the two bandages together behind.

2. *For Fracture of the Clavicle.*—See Fractures.

3. *To secure Splints.*—The bandages must be folded broad when splints are to be fixed to the thigh or knee, and folded narrow when splints are to be fixed to the leg, ankle, forearm, or wrist.

Splints may be fixed in either of the following ways:

A. Apply the splint to the limb, raise the limb and steady it, place the centre of the bandage over the splint at the spot where it is to be fixed, pass the two ends round the limb, cross them inside, bring them forward, and tie off on the outside over the splint.

B. *By the 'Looped Triangular Bandage.'*—Take a bandage folded narrow, double it upon itself, place the loop upon the splint on the outer side of the limb, pass the ends round the limb from without inwards. Now either pass one end through the loop, or the two ends through the loop, one from right to left and the other from left to right; tighten the bandage by steadily drawing in the two ends, and knot them.

The triangular bandage, to arrest bleeding, may be used as an improvised tourniquet, or in adopting the method of forced flexion (see Hæmorrhage).

Rifle Splint.—The following are the rules for the application of a rifle splint. See that the rifle or magazine contains no cartridges. If the splint be for the right side, remove the bolt.

Take a narrow-fold bandage, place it over the heel plate of butt in such a way that two-thirds of its length are on what will be the outer side, and one-third on the other side of the butt: take a half hitch with the long end round the butt, making a half knot on outer side. Tie the ends with a reef knot so as to form a loop, the knot of which must come below the stock and be on a level with the projecting part. This is for the perineal bandage to pass through, and is called the butt-loop. Leave the magazine in position: place the rifle along the injured limb, butt towards the armpit, trigger guard to the front. Take a narrow-fold bandage, place its centre over the ankle of the injured limb, pass the ends behind, enclosing muzzle of rifle, cross behind. With the outer end take a turn round the muzzle in front of the sight or D for sling, bring both ends up, cross over instep and tie off on the inside of the foot. Take a narrow fold, place its centre in the fork, bring one end out behind, the other in front of the limb; pass one end through the butt-loop and tie, gradually tightening the knot as the limb is gently drawn to its proper length. Pass both ends round small of butt and tie off. Take two long splints, place one on the top and the other along the inner side of the thigh and fix at each end by a narrow-fold bandage tied off over the rifle in the manner described in paragraph B above. Take a broad-fold bandage, place the centre over the butt of the rifle, pass the ends round the

body, and tie off on the opposite side. Tie the patient's legs together by placing the centre of a broad fold over both ankles, pass the ends behind, cross, bring up and tie off on top between the legs.

In fractures of the limbs the bandages which fix the splints should be tied as far from the fracture as possible.

2. The Roller Bandage and its Application.

The roller bandage is essentially the bandage for use in all cases where it is required to maintain firm pressure—*e.g.*, in the control of bleeding, in the fixation of dressings after operations, etc. As the roller bandage requires considerable experience and skill for its proper application, it is not adapted as an emergency bandage for non-professional hands.

The roller bandages may be divided into :

1. *Elastic Bandages.*—These are of several kinds—woven, indiarubber, etc. They are used to check the flow of blood when drawn tightly round a part, and to give support, as in varicose veins.

2. *Semi-elastic Bandages.*—These are made out of flannel, domette, silk, cotton-net, etc.; they lie more smoothly than those of the next group, and as, owing to their elasticity, reversing is unnecessary, they are easier to apply.

3. *Inelastic Bandages.*—These are made out of grey shirting, unbleached or bleached calico or linen, and are the common roller bandages in general use.

The Sizes of the Roller Bandage are as follows :

Part.	*Breadth.*	*Length.*
For head	2 to 2½ inches	5 to 7 yards
,, finger	¾ inch	1 to 2 ,,
,, hand	1 ,,	4 to 5 ,,
,, arm	1½ to 2½ inches	8 to 12 ,,
,, shoulder	2½ ,,	8 to 12 ,,
,, chest	3 to 4 ,,	6 to 8 ,,
,, leg	2½ ,,	10 to 12 ,,
,, foot	2½ ,,	4 ,,

To Roll the Bandage.—Proceed as follows:

Turn in enough of one end to start the roll; place the bandage upon the thigh, with the partial roll near the groin, and roll the cylinder, with the palm of the hand upon it, from above downwards. Special machines are in use for the purpose of rolling bandages.

The named parts of the bandage are: The face, or initial end; the rolled-up or terminal end; the body.

When a bandage is rolled up from one end only, it is termed a 'single-headed' roller; when from both ends, a 'double-headed' roller.

Points to be observed in the Application of the Roller Bandage.—1. Before applying the bandage, see that it is tightly rolled.

2. Stand in front of the limb to be bandaged, and place the limb in the exact position in which it is to be kept; *i.e.*, in the upper limb, bend the elbow, placing the hand midway between pronation and supination.

3. Commence the bandage by placing the outside of the bandage to the inside of the limb, and taking a couple of turns round the limb to fix it.

4. Always bandage from below upwards, except in the case of the trunk.

5. Always bandage from within outwards, over the front of the limb.

6. While bandaging, never unroll more than 2 or 3 inches of the bandage at a time.

7. Let each succeeding turn of the bandage overlap two-thirds of the preceding one.

8. Bandage the limb firmly, but never too tightly or too loosely. On running the hand down a bandage, if the edges turn it is applied too loosely.

9. Use firm, equable pressure throughout the bandage. If when the bandage is removed red lines are seen on the skin, it indicates that unequal pressure has been applied.

10. In bandaging leave the tips of the fingers and toes uncovered, in order to see whether the bandage has been applied too tightly. If the tips become blue and cold, loosen the bandage.

11. Apply the bandage smoothly, leaving no wrinkles.

12. Keep all the margins parallel, and keep the crossings and reverses in one line and towards the outer side of the limb.

13. Never reverse a bandage over a sharp bone.

14. Always form a figure-of-eight at a joint.

15. Never apply a bandage wet: when dry, it will shrink and bind the limb too tightly.

16. End by fixing the bandage securely with a pin.

17. Never reapply a bandage without first completely winding it up.

18. In taking off a bandage, gather the slack into a loose bundle, and pass it round and round.

The Roller Bandage may be applied in the following ways:

1. As a circular bandage.
2. As a spiral bandage.
3. As a reversed spiral bandage.
4. As an oblique bandage.
5. As a figure-of-eight bandage, and its modification, the spica.

1. **The Circular Bandage** consists of a series of turns made round and round a part (such as the head), each turn entirely overlapping the previous one.

2. **The Spiral Bandage** consists of a series of spiral turns, each one overlapping the preceding one by about two-thirds, and can only be applied to those parts which vary but slightly in their circumference, such as the forearm, just above the wrist, and the finger.

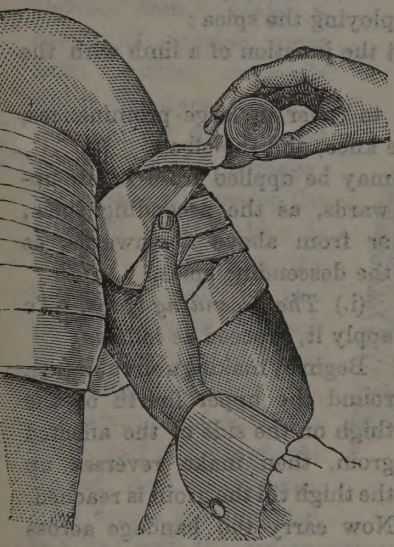
3. **The Reversed Spiral** consists of a series of spiral turns in which the bandage is turned over on itself while it is being applied, the object of turning the bandage being to make it lie smoothly and firmly over parts of the limbs which constantly vary in diameter, such as the forearm, the calf, etc.

In order to reverse, proceed as follows: Hold the head of the bandage lightly in one hand, place the thumb of the disengaged hand on the lower border of the bandage on the outer side of the limb, slacken about 3 inches of the bandage, turn it over, reverse it downwards, pass it over the limb to the opposite side, keeping its lower edge parallel with that of the turn below;

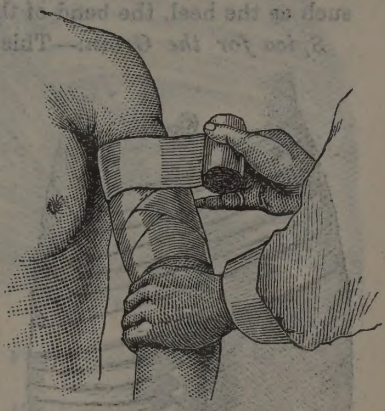
when the outer side of the limb is reached, make the reverse again, and so on.

This bandage is firmer than the simple spiral, and is to be preferred for fixing splints to a fractured limb. Its disadvantages are that it is somewhat liable to slip, and it is not elastic.

4. **The Oblique Bandage.**—This consists of a series of rapidly ascending spirals, which pass up the limb without their edges overlapping. It is used only for holding dressings loosely in their place.



APPLICATION OF THE REVERSED SPIRAL.



APPLICATION OF THE FIGURE-OF-EIGHT BANDAGE.

5. **The Figure-of-Eight Bandage.**—This consists of a series of loops forming a figure of eight, each figure overlapping the one below by about one-third the width of the bandage.

In order to apply the figure-of-eight bandage to the hand, proceed as follows:

Place the end of the bandage on the front of the wrist, bring it across the back of the hand and below the thumb and across the palm at the root of the fingers, then across the back of the wrist, then across the palm of the hand and across the back

of the wrist over the first turn; repeat these movements (taking care that the loops overlap each other by about one-third the width of the bandage), as often as it is necessary, and finally fix the bandage with a circular turn round the wrist.

The figure-of-eight bandage is employed chiefly in the neighbourhood of joints; it is less firm but more elastic than the reversed bandage.

The Spica Bandage.—This is a modification of the figure-of-eight bandage, having one loop very much longer than the other. It is used to retain dressings and to keep up pressure on a part.

There are two methods of employing the spica:

1. The ordinary spica, used at the junction of a limb with the trunk.

2. The divergent spica, used to cover in large prominences, such as the heel, the bend of the knee, and the elbow.

Spica for the Groin.—This may be applied from below upwards, as the ascending spica, or from above downwards, as the descending spica.

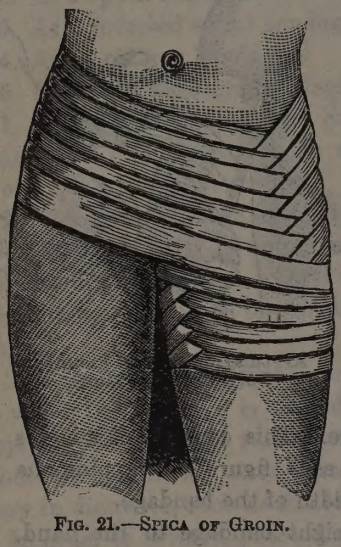


Fig. 21.—Spica of Groin.

(i.) *The ascending spica.*—To apply it, proceed as follows:

Begin by making a circular turn round the upper fourth of the thigh on the side of the affected groin, then make reverses up the thigh till the groin is reached. Now carry the bandage across the front of the groin outwards and upwards to a little above the hip-joint, then across the small of the back and over the hip on the opposite side to the front of the abdomen, across the pubes, back again to the affected groin, then to the outside of the thigh, round the back of it to the outside and over the groin, and then again across the body, and so on, making each turn go a little higher, about ½ inch above the lower edge of the preceding turn, and finally fix with a pin.

(ii.) *The descending spica.*—To apply it proceed as follows: Lay the tail of the bandage over the affected groin, carry it over the pubes, across the abdomen, to the outer side of the other hip, then across the small of the back to the hip on the affected side, over the hip and across the front of the thigh to the inner side; then round the thigh, back to the first turn, and so on, making each turn a little lower than the preceding.

Spica for the Shoulder.—This may be applied in two ways:

(i.) *From below upwards*, thus: Make a couple of circular turns from within outwards round the upper third of the arm on the affected side, to fix the bandage; then make reverses up the arm till the shoulder is reached; now carry the bandage behind the shoulder across the back to the opposite side, under the armpit on that side, then across the front of the chest, well up towards the tip of the breast-bone; then across the shoulder, in a line with the reverses upon the bandage on the arm; then below the shoulder, from behind forwards, to the front; and then across the back, and so on.

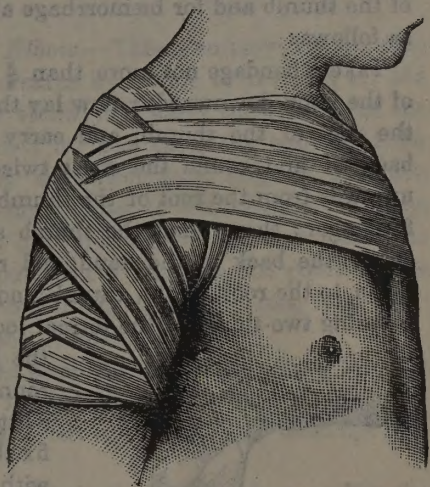


FIG. 22.—SPICA OF SHOULDER.

(ii.) *From above downwards*, thus: After bringing up the bandage by means of reverses to the shoulder, carry the bandage over the front of the shoulder to the highest point; then round the back to the opposite side; then under the arm on that side, and then across the front of the chest and the front of the arm on the affected side; then under the armpit and over the shoulder again, but this time on a lower level than the preceding turn, and so on.

Spica for Breast.—To apply this proceed as follows:

Lay the tail of the bandage about 4 inches below the affected breast; now make two horizontal turns round the body, to fix the bandage; then carry the bandage under the affected breast, and over the opposite shoulder; then down the back, and again to the front, on a slightly higher level than the preceding turn; now horizontally across the body, and so on, till the whole breast is covered, each turn horizontal and oblique being on a little higher level than the preceding.

Spica for the Thumb.—This is the regular bandage for sprain of the thumb and for hæmorrhage about the part. It is applied as follows:

Take a bandage not more than ¾ inch wide; place the palm of the hand downwards; now lay the tail of the bandage below the root of the thumb, and carry the bandage across to the back of and round the wrist twice, to fix it; now carry it upwards from the root of the thumb to between the thumb and forefinger; then round the thumb as high as it will lie; then across the back of the hand, and round the wrist again, back again to the root of the thumb; now again round the thumb, covering two-thirds of the former loop, back across the back of the hand, and so on, the loops round the thumb each time being a little nearer the wrist. Finally, fix the bandage round the wrist with a safety-pin, or by splitting the ends and tying.

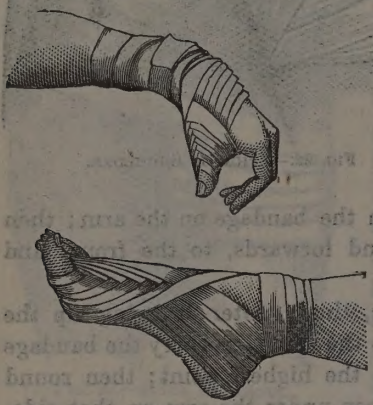


Fig. 23.

Spica for the Great Toe.—This is applied in precisely the same way as the above, the ankle taking the place of the wrist.

Divergent Spica for the Heel.—To apply this proceed as follows:

Lay the tail of the bandage against the outer ankle, and carry the roller under the sole to the inner ankle, and from here within outwards, over the back of the foot, to the point where the bandage started; now carry the bandage over the tip of the heel, placing the

middle of the bandage over the most projecting part of the heel; then carry the bandage inwards, over the sole of the foot, then across the back of the foot, then below the point of the heel, catching the lower edge of the loop which goes over the heel; then again take the bandage over the instep, across the back, and now above the point of the heel, and over the upper oose edge of the loop which goes over the heel; back to the instep, and over the lower point of the heel again, and so on, each loop over the heel being a little further from the point than the preceding one.

Divergent Spica for the Elbow.—This is employed as follows:

Carry the roller up the forearm by means of reverses till the elbow is reached, bend the elbow, and carry the middle of the bandage well over the point of it; now carry the bandage from within outwards, and catch the lower loose edge of the turn above; then take the bandage across to the inner side of the elbow, bring it from within outwards again, and now catch the upper loose edge of the loop which encircles the point of the elbow. Continue these figures-of-eight, making each loop overlap from within outwards the preceding loop.

This bandage is employed when it is required to keep the arm in a bent position, as after fractures and injuries to the joint.

Divergent Spica for the Knee.—To apply this bandage proceed as follows:

Slightly bend the knee, lay the tail of the bandage against the inner side of the knee, carry the bandage over the front of the kneecap to the outer side of the knee, and back to the starting-point; then across the front of the knee, catching the lower loose margin of the turn above; then back to the starting-point, and again across the front of the knee, this time catching the upper loose margin of the first turn. Continue these figures-of-eight above and below alternately.

This bandage is used to give support to the knee-joint when it is inflamed.

To apply a Roller Bandage to the Hand, Wrist, Forearm, Elbow, and Arm.—Proceed as follows:

Take a 2½ inch roller bandage. Make a couple of turns round the wrist, beginning at the root of the thumb, and passing out-

wards over the back of the wrist, then carry the bandage upwards and backwards over the back of the hand to the root of the little finger; now take one turn round the fingers, leaving the tips free, then make a figure-of-eight round the wrist and hand, and repeat this three or four times; now make spiral turns round the forearm till the swell of the forearm is reached, then apply the reverse spiral till the bulging of the forearm begins to diminish; bend the elbow, making a figure-of-eight over it (leaving the point free, unless it is injured, in which case cover it), then make a few circular turns round the lower part of the upper arm, and then begin to reverse till the armpit is reached, and secure the end with a safety-pin.

Note.—Never bandage the forearm and arm in a straight position, and then flex the elbow afterwards, as this will produce compression of the veins, and lead to swelling of the hand and forearm and subsequent mortification.

Finger Bandages—*The Continuous Finger Bandage.*—To apply this bandage proceed as follows:

FIG. 24.—FINGER BANDAGE.

Take a bandage ¾ or, still better, ⅝ inch wide and 4 yards long. Make a turn round the wrist, leaving about 6 inches of the end free, take the bandage over the back of the hand to the inner side of the little finger, carry it down to the level of the nail, then make circular turns round the finger to the root, then from the thumb side of the root carry the bandage up the back of the hand, round the wrist, and again down the back of the hand to the ring-finger; now proceed successively with this and each of the other fingers till all are covered, and tie off the bandage by its loose end.

This bandage is used to prevent swelling when splints and dressings are applied to the forearm. It should always be applied before any other bandages are put on higher up. It is also of great use for burns or scalds of the fingers.

Any one finger may be bandaged in a similar manner to the above.

To bandage the Lower Extremity.—Proceed as follows:

Take a 2½ to 3 inch roller bandage 6 to 8 yards long. Extend the leg, and place the foot at right angles to it; apply the free end of the bandage over the inner ankle-bone, carry it across the instep to the root of the little toe, then across the foot to the ball of the great toe, bring it over the instep and the outer ankle-bone, round the back of the leg a few inches above the heel, overlap, and fix the commencement of the bandage; repeat this figure-of-eight once, and when the bandage again reaches the root of the little toe, make a spiral round the foot, then make two reverses over the lower part of the foot—these reverses being opposite the middle of the back of the foot—then make two turns of the figure-of-eight round the heel, then carry the bandage by three spiral turns round the ankle, and then by reverse spirals till the knee is reached; now make figures-of-eight over the knee-joint, either covering the point or leaving it free, then carry the bandage up the thigh by reverse spirals, and end with a spica of the groin.

Bandages for the Head—1. *The Capeline Bandage.*—To apply this bandage proceed as follows:

Fasten two roller bandages together, one 2 inches wide and 4 yards long, and the other 1½ inch wide and 5 yards long. Make the patient sit down in a low chair, stand behind him with a roller in each hand, and place the middle of the bandage against the centre of the forehead; now carry the rollers, one on each side, above the ears and below and behind the occiput, cross the wide roll over the narrow roll, transfer the wide roll to the right hand and the narrow roll to the left, and pull the bandage tight; now carry the small roll upwards along the middle of the head and down to the root of the nose. Bring the wide roll horizontally forwards above the right ear and across the narrow roll at the root of the nose, take the narrow roll back over the top of the head a little to the left of the middle line, fix it behind as in front by the wide roll, now bring it over to the front a little to the right of the middle line, again fix it by the wide roll; continue these operations backwards and forwards,

each time making the bandage which is covering the top of the head diverge a little from the middle line till the ears are reached; cut off the vertical bandage in front, and fix by taking two extra turns with the horizontal bandage round the head, and pin in front.

This bandage is used to fix dressings on the head.

The disadvantages of it are that it is troublesome to apply, it is hot, and if it is applied at all tightly, it is apt to become painful.

2. *The Twisted or Knotted Bandage.*—To apply this, proceed as follows:

Take a bandage about 2½ inches wide. Unroll the bandage for

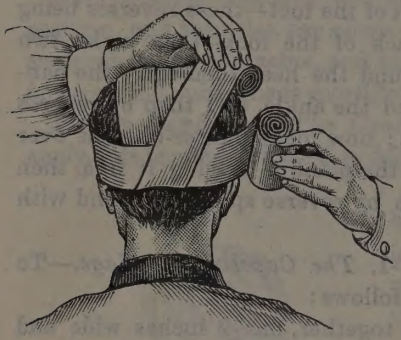


FIG. 25.—THE CAPELINE.

FIG. 26.—TWISTED BANDAGE FOR HEAD.

about a foot, take the end in the right hand, place the bandage against the temple, carry the roll round the forehead and occiput, and bring it back to the unrolled end; now twist it round this end sharply, and carry the roller down below the chin and over the vertex till the unrolled end is reached, now twist it round this again and make a horizontal turn round the head, bring it back and repeat the vertical turn; repeat these turns till sufficient pressure is obtained, and then fix the bandage by knotting the two ends together.

This bandage is used to exert pressure on a graduated compress placed over a bleeding wound of the temple.

To bandage the Chest.—Proceed as follows:

Take a roller 6 inches wide and 6 to 8 yards long, and apply it

from below upwards in a simple spiral, making each spiral overlap the one below by about one-half its breadth. When the last spiral is completed, pin behind, leaving about 1½ yard free; bring this end over one shoulder, carry it obliquely across the bandage in front to its lowest edge, and fasten it by pins or stitches to all the underlying turns.

To bandage the Abdomen.—Proceed in the same way, but bandage from above downwards, and fix by bringing the free end from behind forwards between the thighs.

3. Bandages of Special Form and their Application.

1. The Square Bandage.—This is used as a protection for the entire head and neck, and is applied as follows:

Take a handkerchief a yard square, and so fold it as to allow the under layer to project about 4 inches beyond the upper, lay the middle of the bandage upon the top of the head, with the longer flap covering the eyes, the margin of the upper flap in a line with the eyebrows, and the short borders hanging upon the shoulders; take the two outer corners and tie them firmly under the chin, take the border of the under fold, turn it over the forehead, take its two corners, carry them round, and tie them in a reef knot behind the head.

2. The Four-tailed Bandage.—This bandage is used to keep a dressing on the chin, top, back or front of head, knee, etc., and for a broken jaw.

(1) *The Four-tailed Bandage for the Jaw.*—Take 1½ yard of a 3 inch roller, make a slit in the centre of it about 3 inches long, and then slit down the ends to within 6 inches of the centre, place the chin in the central slit, carry the two upper ends behind the neck and tie them, carry the two lower ends to the top of the head and tie them, then tie the four ends together behind the head.

(2) *Four-tailed Bandage for the Head* (the Four-tailed Cap).—Take a piece of calico 6 to 8 inches wide and 2 feet long, slit it up at the narrow ends for a considerable distance.

To apply it to the front of the head: Lay the bandage across the front part of the top of the head, carry the two anterior

ends back behind the head and tie; carry the two posterior ends forward under the chin and tie.

To apply it to the back of the head: Place the bandage across the back part of the top of the head, draw the two posterior ends forward, and tie them in front on the forehead; tie the two anterior ends under the chin.

(3) *Four-tailed Bandage for the Knee.*—Take a piece of calico 8 to 10 inches wide and 3 feet long, and slit it down at the narrow ends. To apply it, lay the centre in front of the kneecap, cross the ends behind, bring them forward, tie the two upper ones above the kneecap, and the two lower ones below.

3. **The Many-tailed Bandage** (Bandage of Scultetus).—This is employed in cases where it is not advisable to disturb a part more than is necessary.

To make the bandage for a limb: Take a slip of bandage the same length as the limb it is required to cover, spread it out, lay strips across it 6 inches longer than itself, with their centres across the centre of the perpendicular strip, and make these cross-strips overlay each other by about one-third their width; now sew all these bandages together.

To apply the bandage: Lay the limb along the central strip, and fold the strips over from below upwards, and secure the last two strips to the others by a pin on each side.

4. **The T Bandage.**—This bandage is used to retain dressings on the perinæum. It is made by taking a bandage 3 inches wide and 1½ yard long, and sewing this to a similar strip 1 yard long.

To apply it, pass the long strip round the hips, so that the short strip lies along the sacrum, and pin; now bring the short strip between the thighs, and pin to the other in front.

CHAPTER II.

HÆMORRHAGE AND ITS IMMEDIATE TREATMENT.

Definition—Symptoms. *External Hæmorrhage:* Capillary—Venous—Arterial—Methods of Treatment—Digital Compression—Flexion—Tourniquets—Table of Arteries. *Internal Hæmorrhage:* Causes—Varieties—Treatment.

Definition.—Hæmorrhage may be defined as the escape of blood from the heart or the bloodvessels.

The Causes of Hæmorrhage.—Injury or disease.

Situation.—Hæmorrhage may be either (1) *external*—this is more frequently the result of injury; or (2) *internal*—this is due more often to disease affecting the bloodvessels or their neighbouring structures.

The Symptoms of Hæmorrhage are the actual appearance of blood (always seen in external hæmorrhage, and sometimes in internal hæmorrhage, *e.g.*, in bleeding from the lungs, etc.), and the constitutional effects, more or less severe, which follow the loss (*i.e.*, the signs of syncope or fainting), and which are indicated by a cold and clammy skin, a pallid and livid face, dilated pupils, feeble and irregular breathing, an irregular and almost imperceptible pulse, dizziness, inclination to vomit, and loss of consciousness. These constitutional effects are in direct proportion to the suddenness of the loss of blood; *i.e.*, the quicker the loss, the more profound the syncope.

Varieties of Hæmorrhage.—Hæmorrhage may be:

1. **Capillary.**—This, which is the least dangerous variety, is indicated by a general oozing from the whole surface of the wound, the colour of the blood being more or less a brick-red.

2. **Venous.**—This is indicated by the blood flowing in a continuous stream and coming from the side of the wound furthest from the heart (*e.g.*, from the lower side of a wound of a limb), the colour of the blood being a dark purple.

Venous hæmorrhage comes next in seriousness to arterial.

3. **Arterial.**—This, which is the most serious form of bleeding, is indicated by the blood flowing in a forcible pulsatile stream (which rises with every beat of the heart and falls in the

interval) from the side of the wound nearest the heart (*e.g*, from the upper side of a limb wound), the colour of the blood being a bright red.

External Hæmorrhage.

The Treatment of Capillary Hæmorrhage.—The bleeding part should be exposed to the air, and pressure applied to it, either by means of perfectly clean fingers or a piece of clean sponge or lint which has previously been well dipped in some antiseptic solution.

If either of the above methods fail, some styptic (such as clean cold water, hot water at a temperature of 100° to 120° Fahr., burnt or dried alum, tincture of steel, turpentine, common salt, tannic or gallic acid, nitrate of silver, etc.) must be applied to the wound.

Caution.—In the employment of styptics care must be taken that they are not of such intensity as to destroy the living tissues to which they are applied.

The Treatment of Venous Hæmorrhage.—In treating bleeding from veins, the following measures are to be adopted:

1. Remove all constrictions which impede the backward flow of blood to the heart; *i.e.*, all tight clothing about the neck and chest must be removed, garters undone, etc.

2. Elevate the bleeding part above the level of the heart; therefore, if the bleeding is from a limb, raise it.

3. Apply digital pressure (pressure with the fingers) *directly* to the surface of the wound, and as soon as possible supersede this by an antiseptic pad and bandage.

The Treatment of a Burst Varicose Vein.—The superficial veins of the lower extremities are liable to become dilated, or varicose, from the pressure of the column of blood on their walls, and the insufficiency of their valves, and may burst, leading to serious, or even fatal, hæmorrhage if not promptly attended to. The measures to be adopted in dealing with a condition of this description are as follows:

1. Place the patient on his back.
2. Raise the wounded leg.
3. Remove all constrictions round the limb on the heart side.
4. Place an antiseptic pad directly on the wound, and fix it

with a roller bandage carried from the root of the toes to about a hand's breadth above the seat of the hæmorrhage.

5. Keep the patient in a recumbent position, with the leg slightly elevated for some hours after the accident.

6. If the bleeding has been excessive, keep the patient perfectly warm, to counteract the effect of any sudden weakening of the heart's action.

The Treatment of Arterial Hæmorrhage.—In treating arterial hæmorrhage the following points are always to be considered:

1. The **proper position** of the bleeding part. In all cases

FIG. 27.—COMPRESSION OF CAROTID.

the first thing to do is to expose the wound and place the wounded part, if possible, above the level of the heart, *i.e.*, elevate it.

2. The application of **pressure** to stop the bleeding.

3. The **treatment of the constitutional symptoms** (if any) which follow the loss of blood.

'First Aid' Methods of controlling Arterial Hæmorrhage.—The measures to be adopted will depend upon the severity of the bleeding.

A. If the bleeding is not excessive, *e.g.*, in all superficial hæmorrhages, apply:

(i.) **Firm pressure** directly to the bleeding-point by means of absolutely clean fingers, and when the bleeding has quite stopped, place

(ii.) **An antiseptic pad** over the wound, and retain it in position either by means of a folded triangular bandage or a roller bandage. In some situations, *e.g.*, the palm of the hand, a graduated compress (made by superimposing several layers of antiseptic lint upon each other, the smallest being about the size of a sixpence, and the largest that of a shilling) is more effectual than a simple pad.

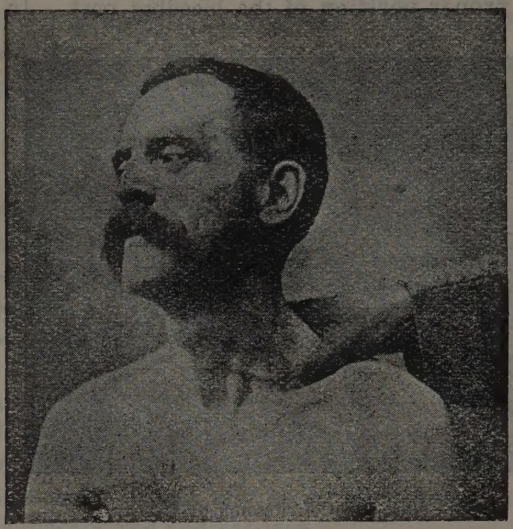


FIG. 28.—COMPRESSION OF SUBCLAVIAN.

B. If the bleeding is excessive, apply:

(i.) **Digital compression** (compression by means of the fingers), if possible, to the main artery supplying the part with blood. This pressure must be applied to the artery between the wound and the heart, and at a point where some hard basis of support is furnished against which the artery can be pressed, *e.g.*, where the vessel passes over or along the side of a bone. The value of digital compression is that it can be applied **immediately**.

The following points are to be remembered in applying digital compression:

1. Use the thumb to make the pressure.

2. Get the artery firmly against the bone, and press directly upon it.

3. Compress the artery only, avoiding all adjacent structures, such as nerves and veins.

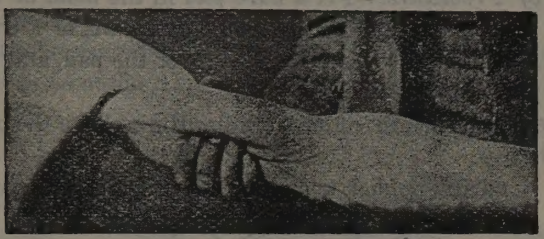


FIG. 29.—COMPRESSION OF BRACHIAL.

4. Remember that digital compression is only applicable in certain parts, as the limbs, the neck, and some parts of the head and face; and that it cannot be maintained effectively by one person for more than fifteen consecutive minutes at a time.

(ii.) Supersede digital compression by means of a **hard pad**

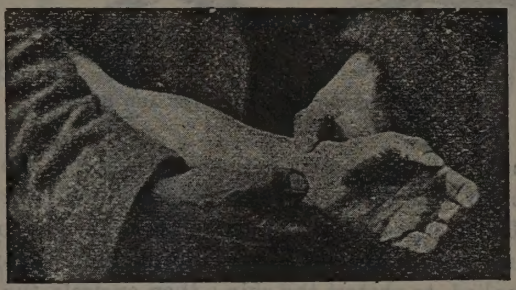


FIG. 30.—COMPRESSION OF RADIAL AND ULNAR.

placed on the main artery, and retained in position by the application of a bandage.

In the case of arterial bleeding from the **limbs**, digital compression can be superseded by the following:

c. **Compression by forced flexion**, or by the application of

pressure to the main artery by bending it acutely at the point where it passes over a joint.

The points where this method can be used are in the **armpit**, the **bend of the elbow**, **bend of the groin**, and the **bend of the knee**.

Mode of Procedure.—Fix a hard pad in the bend of the joint which is next above the bleeding-point by means of a triangular bandage folded narrow, bend the limb over the pad, and bandage it to the part above.

D. **The constriction of the whole limb** above the bleeding-point either—

1. By a narrow-folded triangular bandage tied loosely in a

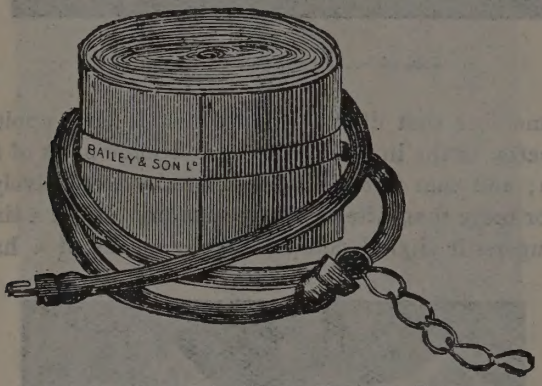


FIG. 31.—ESMARCH'S ELASTIC TUBE AND BANDAGE.

knot round the limb; a stick is then inserted into the loop, and twisted round several times to make the loop tight; or

2. By Esmarch's elastic band, which is applied as follows:

First fix a turn of a roller bandage to the limb where the band is to be applied, to protect the skin; then encircle the limb two or three times with the band, well stretched, and fasten off.

Caution.—In applying Esmarch's band care must be taken that it is no tighter than will just suffice to stop the circulation.

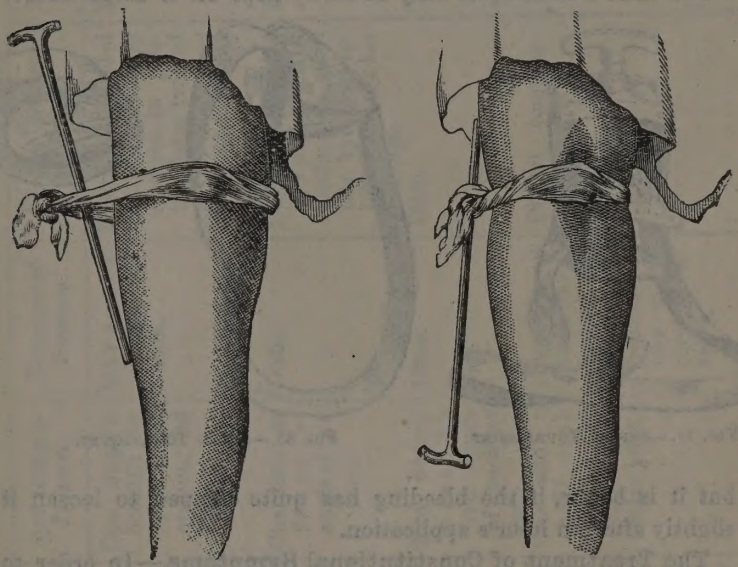
The disadvantage of the above method (D) is that the complete arrest of the blood-supply to the parts below the constriction favours the tendency to mortification of the limb; hence it is preferable to employ

E. **Tourniquets**, which are instruments constructed on the principle of a strap to encircle the limb, a pad to place on the vessel, and a screw, buckle, or other means to tighten the strap.

The advantage of tourniquets is that effectual pressure is applied to the main artery, without undue constriction of the whole limb.

The kinds of tourniquets most suitable are:

1. **The Improvised Tourniquet**, or '**Garrot.**' This is made by folding a handkerchief like a cravat, and placing some hard



FIGS. 32, 33.—THE IMPROVISED TOURNIQUET, OR 'GARROT.'

substance in its folds, to act as a pad. The pad is placed on the vessel, the handkerchief is loosely knotted, a stick is passed between the knot and the limb; a soft pad is now placed between the stick and the limb, and the stick is twisted round several times, till the vessel is compressed, and then tied to the limb to fix it.

2. **Völker's Stick Tourniquet.**—This can be applied only to the arm, and is made by taking two sticks 6 to 8 inches long, ¾ inch thick, and notched at their ends. One stick is placed on

the artery, and the other on the opposite side to it, and the two are then tied together at their ends, top and bottom.

3. **The Field Tourniquet.**

4. **The Screw Tourniquet.**

The figures sufficiently explain the construction of these two tourniquets.

The screw tourniquet differs from the field by having a screw by means of which the strap can be further tightened after buckling on.

The time a tourniquet may be safely kept on is three hours,

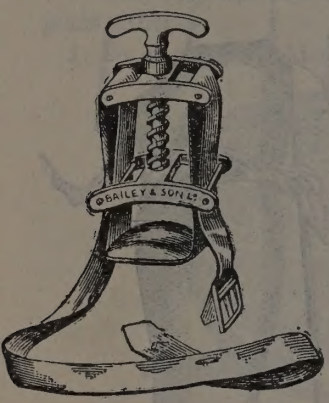


FIG. 34.—SCREW TOURNIQUET.

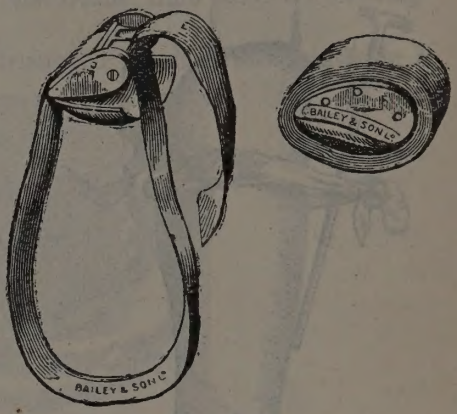


FIG. 35.—FIELD TOURNIQUET.

but it is better, if the bleeding has quite stopped, to loosen it slightly after an hour's application.

The Treatment of Constitutional Symptoms.—In order to counteract syncope or fainting due to the loss of blood, the patient must be kept at absolute rest, in a recumbent position, with the feet slightly raised. His clothes should be removed; his body should be wrapped round with warm blankets, and hot-water bottles should be applied to his feet. If able to swallow, stimulants are to be given in small quantities, but only after the hæmorrhage has entirely stopped. If the loss of blood has been very excessive, the breathing may be very much embarrassed, or it may actually stop. Here artificial respiration must be performed.

Treatment of Hæmorrhage by Compression of the Principal Arteries of the Body.

Part wounded.	*Artery to compress.*	*Course of Artery.*	*Spot to apply Pressure.*	*Direction of Pressure.*	*Kind of Pressure employed.*	*Treatment to be adopted after Hæmorrhage has stopped.*
1. Temple, front or top of head.	Temporal.	Passes over the zygoma.	One finger's breadth in front of opening of ear.	Directly against the bone.	Digital, superseded by pad on artery, retained in position by a twisted triangular or knotted roller bandage.	Dress the wound.
2. Face below the eyes.	Facial.	Passes over lower jaw.	One inch in front of angle of jaw.	Ditto.	Digital, superseded by a pad on artery retained in position by a narrow-fold triangular bandage.	Ditto.
3. Back of head.	Occipital.	Passes over the mastoid process.	Two fingers' breadth from centre of back of ear.	Ditto.	Ditto.	Ditto.
4. Neck.	Common carotid.	Passes along side of neck from a point midway between angle of jaw and mastoid process to sternal end of clavicle.	One and a half inch above the sterno-clavicular joint.	Inwards and backwards against the transverse process of the sixth cervical vertebra.	Digital compression.	When the bleeding has completely stopped, dress the wound, bend the head forward towards the chest, and fix it there by bandages and pillows.

Treatment of Hæmorrhage by Compression of the Principal Arteries of the Body—*continued.*

Part wounded.	*Artery to compress.*	*Course of Artery.*	*Spot to apply Pressure.*	*Direction of Pressure.*	*Kind of Pressure employed.*	*Treatment to be adopted after Hæmorrhage has stopped.*
5. Shoulder or axilla.	Subclavian.	Passes over upper surface of first rib.	Behind middle of clavicle.	Downwards and backwards against the first rib.	Digital, superseded by the padded handle of a door-key.	Dress the wound, apply a spica bandage to shoulder to retain the dressings, and place forearm in a large arm-sling.
6. Upper third of arm.	Axillary.	Passes over apex and along outer side of axilla.	At the junction of the outer with the middle third of the armpit.	Outwards and a little backwards against the humerus.	Digital.	Ditto.
7. Lower two-thirds of arm.	Brachial.	At the inner border of the biceps, in a line with the inner seam of the coat.	Middle of arm.	Outwards and backwards against the humerus.	Digital, superseded either by Völker's stick tourniquet or by forced flexion; *i.e.*, firm pad in axilla, and arm bandaged to side of chest, or by Esmarch's band, or a tourniquet ('improvised,' screw, or field).	Dress the wound, and place forearm in a large arm-sling.
8. Forearm.	Brachial.	Under inner edge of tendon of biceps.	At bend of elbow.	Downwards and backwards against the humerus.	Forced flexion at bend of elbow, or by any of the methods for No. 7.	Dress the wound, and sling the elbow.

9. Palm of hand.	Radial and Ulnar.	Along outer border of wrist. Along inner border of wrist.	One inch above wrist. Ditto.	Directly backwards against the radius and ulna.	Digital, superseded by any of the methods for No. 7.	After dressing the wound, place a hard pad in the palm, flex the fingers over it, bandage and sling the elbow, with the injured hand resting against the opposite shoulder.
10. Upper third of thigh.	The common femoral.	Passes over the pubes.	At bend of groin midway between symphysis and iliac spine.	Directly downwards against the pubes.	Digital, or forced flexion, with a hard pad on the artery.	Dress the wound, fix the pad on artery and dressings on wound with a spica bandage to the groin, then apply a long splint to outer side of the injured limb, and keep the patient in a recumbent position, with the foot slightly raised.
11. Lower two-thirds of the thigh.	Superficial femoral.	Passes along a line drawn from middle of bend of groin to inner side of knee.	Middle of thigh.	Outwards against the femur.	Digital, superseded by Esmarch's band or a tourniquet ('improvised,' field, or screw).	Dress the wound, and apply a long splint to outer side of the injured limb, and keep patient in a recumbent position, with the foot slightly raised.
12. The leg.	Popliteal.	Along the middle of the ham.	In the centre of the middle of the ham.	Directly against the posterior surface of the lower end of the femur.	Forced flexion at bend of knee, superseded by any of the methods for No. 11.	Ditto.
13. The foot.	Posterior and Anterior tibial.	Below internal malleolus. Middle of front of ankle.	A thumb's breadth from the internal malleolus. Midway between the two malleoli.	Forwards and outwards against the tibia. Backwards against the tibia.	By a pad placed on each vessel, and a bandage tied round limb to retain the pads in position.	Dress the wound, and keep the foot slightly raised.

Internal Hæmorrhage.

The Causes of Internal Hæmorrhage.—(1) *Injury*, due to blows on the trunk, stab wounds, severe crushes, falls from a height, etc., causing bruising and laceration of internal organs. (2) *Disease*, producing the bursting of a bloodvessel.

The blood may either escape into one of the closed cavities of the body, such as the abdomen, cranium, or thorax; or it may make its escape through an opening in the cavity, artificial or natural.

Serious hæmorrhage into a closed cavity is denoted by the history of the accident, and the signs of syncope or fainting which follow it.

The **Measures** to be adopted in a condition of this description are:

To send at once for medical assistance, and in the meanwhile to treat the constitutional symptoms due to the loss of blood.

When blood makes its escape through one of the natural openings of the body, it may take the form of:

1. Blood-spitting.
2. Blood-vomiting.
3. Nose-bleeding.

1. **Blood-spitting.**—This may proceed from:

(*a*) The **mucous membrane of the mouth**, especially the gums, or from the cavity left after the extraction of a tooth.

Treatment.—If the bleeding is slight, wash the mouth out with hot water as hot as it can be borne, or with a solution of alum, or a strong solution of salt and water, or give pieces of ice to suck.

If the bleeding is from the socket of a tooth, plug it well with a pledget of cotton-wool dipped in a solution of salt and water. If the bleeding is severe, apply pressure directly to the bleeding-point by means of a small pad.

(*b*) The **throat**, due to injury to the windpipe or gullet.

Treatment.—Keep the patient quiet in a lying-down position, and give him small pieces of ice to suck at frequent intervals.

(*c*) The **posterior surface of the mucous membrane of the nose.**

Treatment.—See Bleeding from the Nose.

(*d*) **Bleeding from the Lungs** (Hæmoptysis).—This is indicated by scarlet and frothy blood being coughed up in mouthfuls, and is usually the result of disease of the lungs or injury to the ribs.

Treatment.—(i.) Send at once for medical assistance, stating the exact condition from which the patient is suffering. In the meanwhile,

(ii.) Lay the patient down, with his head and shoulders raised on a pillow; keep him absolutely quiet, and prevent him from talking or making the slightest exertion.

(iii.) Admit plenty of fresh cool air to the room by opening the windows.

(iv.) Give the patient ice to suck, or let him sip cold water, or vinegar and cold water, or a strong solution of alum and water, or a strong solution of cold tea with a lump of ice in it.

(v.) Remove all constrictions round the patient's chest, and apply cold to it either by means of an ice bag or a cloth wrung out in ice-cold water.

If the faintness due to the loss of blood is severe, be cautious in the employment of stimulants, but apply, in conjunction with the above methods, smelling salts to the nostrils and warmth to the feet.

2. **Blood-vomiting** (Hæmatemesis).—This is usually caused by disease affecting the walls of the stomach.

Its occurrence is preceded by faintness, with a feeling of weight at the pit of the stomach, paleness of the face, and a feeble pulse.

The blood vomited is dark in colour, sometimes coagulated and mixed with food, and presenting the appearance more or less of 'coffee grounds.'

Treatment.—The same as that for bleeding from the lungs is to be adopted.

3. **Bleeding from the Nose** (Epistaxis).—This may be due to injury to the nose; it may be a sign of disease, or be the result of constitutional disturbance.

Treatment.—If severe, send at once for medical assistance, and take care that the doctor is made acquainted with the

nature of the case. In the meanwhile, undo all the tight clothing round the neck, and make the patient sit down on a chair or sofa with his head slightly thrown back (never allow him to hang his head over a basin), open the window, raise the arms, stretched to their full extent, well above and behind the head, apply a cold wet sponge or towel, or a lump of ice, to the back of the neck between the shoulder-blades, also apply cold to the root of the nose. If the bleeding does not stop, syringe the nose with cold water, or a solution of alum—one teaspoonful to a pint of water—or cold tea. Pinch the nose just below the bridge between the thumb and forefinger, and at the same time take a piece of soft rag, wrap it up tightly, and push it into the bleeding nostril.

CHAPTER III.

WOUNDS AND THEIR IMMEDIATE TREATMENT.

Definition. *Simple Wounds:* Incised—Contused—Punctured—Lacerated—Treatment. *Poisoned Wounds:* Stings—Snake-bites—Dog-bites—Treatment.

Definition.—Wounds may be defined as injuries to the body, with division of the skin and (more or less) of the parts lying underneath it.

Wounds may be—(1) *Simple*, (2) *Poisoned.*

Simple Wounds.—These present the following varieties:

1. **Incised or Clean-cut Wounds**—wounds produced by sharp-edged instruments, with cleanly-divided edges and more or less free bleeding.

2. **Contused or Bruised Wounds**—wounds produced by means of blunt instruments, causing bruising of the parts, with little or no external bleeding, but subsequent discoloration of the surrounding parts.

3. **Punctured or Stab Wounds**—wounds produced by sharp-

pointed instruments, very often resulting in considerable bleeding and deep internal injuries.

4. **Lacerated Wounds**—wounds caused by tears from machinery or by bites of animals, with ragged, torn edges and very little bleeding.

In the **Immediate Treatment** of wounds the following points must be borne in mind:

1. To arrest the bleeding.
2. To cleanse the wound and keep it clean.
3. To keep the wounded parts at rest.
4. To protect the wound by some dressing material.
5. To treat any constitutional symptoms, such as shock, that may be present.

To arrest the Bleeding.—This has been sufficiently treated of in Chapter II., 'Hæmorrhage and its Immediate Treatment.'

Cleansing the Wound and keeping it Clean.—In order to cleanse the wound and keep it clean, the following points are to be remembered:

1. Not to touch the wound with dirty hands or instruments. There is no justification for introducing more dirt into a wound which may be already dirty.

2. Not to wash the wound with water procured from any source, unless it has been boiled or contains some antiseptic.

Therefore proceed as follows:

Before attempting to touch the wound, first wash the hands well with warm water and soap, and then rub them with turpentine, or thoroughly rinse them in a carbolic solution (1 in 40). Then, to cleanse the wound and free it from dirt, etc., wash the wound thoroughly with an antiseptic solution, such as a lotion of carbolic acid (1 in 20 to 1 in 40) or perchloride of mercury (1 in 1,000 to 1 in 2,000). If the above lotions are not at hand, or cannot be readily procured, any of the following may be used:

1. Alcohol, in the form of whisky or methylated spirit, with an equal bulk of water.
2. Turpentine.
3. Acetic acid, in the form of vinegar, diluted with an equal quantity of warm water.
4. Condy's fluid—two tablespoonfuls to a pint of warm water.

5. Common salt—a dessertspoonful dissolved in a tumbler of warm water.

6. Water which has been well boiled and allowed to get sufficiently cool.

In washing the wound be careful not to detach any blood-clots which have formed in it, for fear renewed bleeding may ensue.

After the wound has been well cleansed, to keep it clean take a pledget of cotton-wool, soak it well in the antiseptic solution which has been used to wash the wound, squeeze it dry, and place it over the wound.

Dressing the Wound. — To dress the wound proceed as follows:

If ready-made antiseptic surgical dressings are not at hand, or are not easily procurable, place on the wound either a piece of

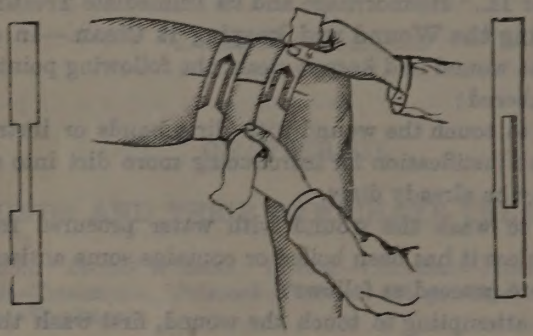


FIG. 36.—STRAPPING APPLIED TO CLOSE A WOUND ACCURATELY.

clean linen which has been recently washed and ironed, or has been well boiled for five minutes and then hung out; or a piece of lint soaked in carbolic solution (1 in 40) or carbolic oil (1 in 40), or in turpentine; and fix it by a bandage applied as indicated in Chapter I.

To keep the Parts at Rest.—After the wound has been dressed, the part, if it is the upper extremity, is to be kept at rest by a sling, or a splint and a sling if the wound is near a joint; if the lower extremity, by a splint.

To treat Shock, if present.—This is to be done as laid down in Chapter II.

1. **Immediate Treatment of Incised Wounds.**—Arrest the bleeding, wash and dress the wound as indicated above. If the edges of the wound gape, after washing it adjust the edges by means of strapping applied as indicated in Fig. 36 (taking care not to completely close the wound), and then dress it.

2. **Immediate Treatment of Contused Wounds.** — Apply pressure to the part, to prevent further swelling, by a pad of cotton-wool or linen, and fix it by a narrow-folded triangular bandage or a figure-of-eight roller bandage; or apply to the part a piece of lint which has been soaked in a lotion consisting of spirits of wine $\frac{1}{3}$, water $\frac{2}{3}$. Change or wet it often. If the bruise is near a joint, apply a splint to keep it at rest.

3. **Immediate Treatment of Punctured Wounds.**—Arrest the bleeding, wash and dress the wound. If the pain is very great, apply a poultice.

4. **Immediate Treatment of Lacerated Wounds.**—Wash and dress the wound. As shock usually supervenes after severe lacerations, it will have to be treated.

Poisoned Wounds.—These may be:

1. **The True Poisoned Wound**—produced by the introduction of decomposing animal matter or other dirt under the skin.

Treatment.—Wash the part immediately with a strong disinfectant.

2. **Stings of Insects.**

Treatment.—Extract the sting with a watch-key. Apply a solution of ammonia, soda, or potash to the part; wash the wound with an antiseptic solution. Shock may sometimes supervene; if so, give stimulants freely.

3. **Snake-bites.**

Treatment.—(i.) Send for medical aid at once.

(ii.) In the meanwhile, prevent the absorption of the poison into the system generally by immediately applying a ligature on the limb between the wound and the heart.

(iii.) Destroy the poison already in the wound by bathing the part first with warm water and encouraging bleeding, then with strong antiseptic solutions, sucking the wound; and finally cauterize it with a red-hot iron or nitrate of silver.

(iv.) Treat the shock by administering stimulants freely and using artificial respiration if necessary.

Caution.—In sucking the poisoned part the operator should see that he has no cuts or fissures about the lips or tongue, and should spit out, instead of swallowing, his saliva.

4. Dog-bites.

Treatment.—The same as for snake-bites.

CHAPTER IV.

SPRAINS, DISLOCATIONS, FRACTURES, AND THEIR IMMEDIATE TREATMENT.

Sprains and Dislocations—Their Signs and Treatment. *Fractures:* Causes—Classification—Signs—Treatment—Splints—Transport of Patient—Compound Fractures.

Sprains or Strains.

Definition.—A sprain is the straining or tearing of ligaments which surround a joint by a sudden twist or wrench; a sprain is practically a 'missed dislocation.'

Causes.—Falls or any sudden and unnatural movement of a joint.

Signs.—Pain, heat, and swelling at the seat of the injury, followed by discoloration of the skin.

Treatment.—Put the parts at complete rest; if it is a joint of the upper extremity, place the limb in a sling; if it is a joint of the lower extremity, place the limb in a back splint, elevate it, and put the patient to bed.

Apply bandages, dipped in cold water, or an ice-bag to the joint; if the pain is severe, and these cannot be borne, bathe the part with hot water at a temperature of 100° Fahr., or apply a hot bran poultice.

Dislocations.

Definition.—A dislocation is the displacement of a bone at a joint.

Causes.—The same as those of a sprain, but in a most violent form.

Signs.—1. Distension of the joint.

2. The end of the displaced bone may be felt through the skin.

3. Alteration in the length of the limb.

4. Loss of movement at the joint.

5. Pain in the joint, increased in trying to move it.

Treatment.—Make no attempt to reduce the dislocation, but send for medical assistance, and put the parts at complete rest and place the patient in an easy position.

Fractures.

Definition.—A fracture may be defined as a broken bone.

Causes.—1. Direct violence, by means of which the bone is broken at the seat of injury.

2. Indirect violence, by means of which the bone is broken at some distance from the seat of injury by transmission of the force applied; *e.g.*, fracture of the collar-bone by a fall on the hand, fracture of the base of the skull by a fall from a height on the feet.

3. Muscular action—snapping the bone across by a sudden and violent contraction, *e.g.*, the kneecap in jumping.

Kinds.—Fractures are of two kinds:

1. *Simple*, where the bone only is broken.

2. *Compound*, where the bone is broken and there is an external wound communicating with the break.

Fractures may present the following varieties:

(i.) *Comminuted*, where the bone is broken into several fragments.

(ii.) *Complicated*, where the fracture is complicated by an injury to the surrounding parts, as the tearing of an artery, vein, or nerve, the opening up of a joint, the tearing of the lung or bladder, etc.

(iii.) *Greenstick*, where the bone is incompletely broken or bent.

(iv.) *Impacted*, where the bones are broken and the ends are jammed together.

Signs.—The signs of a fracture are:

1. Pain, swelling, and deformity at the seat of injury.

2. Unnatural mobility where none should exist.
3. Loss of power in the limb.
4. Shortening of the limb.
5. Crepitus, *i.e.*, a sensation of grating, caused by the rough ends of the bones moving one against the other.

In the **Immediate Treatment** of a fracture the following points have to be considered:

1. The prevention of further injury.
2. The proper transport of the injured person.

The Prevention of Further Injury.—For this the following measures must be adopted:

(i.) Attend to the patient on the spot where the injury has occurred, and especially so if the fracture happens to be in the lower extremity.

(ii.) In handling the patient and examining the injured part, use extreme care and gentleness.

(iii.) Without removing the clothing, bring the bones back into their relative position as follows: First lift the limb by grasping it very gently but firmly above and below the seat of fracture, and then make gentle extension on it to restore it to its natural position as far as possible.

(iv.) Keep the limb fixed in this position by means of splints, which are rigid supports applied to parts to increase either their atural stiffness or to prevent their undue mobility. For the surgeon's use splints are constructed out of various materials, and are shaped to fit the limbs. For the 'first aid' treatment of fractures splints can be made out of various articles in daily use, according to the circumstances the patient may happen to be placed in at the time: *e.g.*, in domestic life, broom-handles, newspapers, wine-bottle covers, stockings filled with straw, umbrellas, walking-sticks, etc.; in workshops, pieces of wood, laths, tools, rules, squares, etc.

With military surroundings, a rifle for fracture of the thigh, a sword or sword-bayonet for fracture of the leg, a bayonet for fracture of the arm or forearm naturally suggest themselves.

Improvised splints should be chosen out of material which is sufficiently stiff to keep the parts in position; they should be made long enough to extend for some distance above and below

the seat of injury, and as wide as the limb to which they are to be applied; and before applying them they should be padded on one side with some soft material, such as tow, cotton-wool, old flannel, triangular bandages (folded), etc., and the padding should extend well over on each side of the splint.

To apply the splints two persons are required; one keeps up gentle extension in the manner indicated above, while the other person applies the splints, one on each side of the limb, with the padded surface to it, and fixes them in position by tying them above and below the seat of fracture with triangular bandages folded narrow, as laid down in Chapter I., or with straps, belts or tapes.

Improvised splints should always be put on in such a way that they can be easily removed if required.

The Proper Transport of the Injured Person.—Here it is important to bear in mind that persons suffering from fractures are not to be removed till the broken bone has been first splinted up; and if able to walk, they should not be permitted to go either to the surgeon or home unassisted, as faintness, giddiness, or even unconsciousness, may supervene even some time after a fracture.

Most persons suffering from fractures of the upper limb can walk if assisted.

Persons suffering from fractures of the lower extremity should always be carried on a stretcher, and this should be done in accordance with the instructions laid down in Part IV.

The Immediate Treatment of a Compound Fracture.—Here proceed as follows:

If there is hæmorrhage, arrest it either by elevating the limb or by applying pressure to the main artery above the wound. If transport is readily available, and skilled help can be quickly obtained, leave the wound untouched; apply splints as indicated above, and remove the patient from the scene of the accident. If skilled aid cannot be speedily procured, undo the clothing at the seat of the injury, thoroughly cleanse the wound with an antiseptic solution, adopting the precautions laid down in the treatment of wounds, apply an antiseptic dressing, then put on the splints as above, and remove the patient.

CHAPTER V.

ARTIFICIAL RESPIRATION AND THE TREATMENT OF ASPHYXIA.

Methods of Artificial Respiration—Silvester's—Howard's—Schäfer's—Asphyxia—Causes—Treatment—Drowning—Choking—Hanging and Strangulation—Poisonous Gases—Signs of Death.

Artificial Respiration.

Various methods have been proposed for performing artificial respiration, but the ones most usually adopted are:

1. Dr. Silvester's method.
2. Dr. Benjamin Howard's 'direct' method.
3. Professor Schäfer's method.

1. The Silvester Method.—This method has the following points to recommend it:

(i.) It is simple.

(ii.) It is effective.

(iii.) It is to a great extent in harmony with the process of respiration in Nature.

(iv.) The expansion of the thorax is artificially insured, and wholly under the control of the operator.

(v.) The patient is not liable to be injured by the manipulations.

(vi.) Both sides of the chest are equally inflated, and a large amount of air inspired.

(vii.) It is most easily adopted and remembered, and can be put into operation by one person.

Mode of Procedure.—Place the patient on his back on the floor, loosen all tight clothing about the neck, chest, and abdomen, and loosen his braces; place a block or pillow under the patient's shoulders (this has the effect of throwing the chest out, extending the neck, and throwing the head back), draw forward the tongue, and get an assistant to hold it in the corner of a handkerchief between the thumb and finger; if unassisted, fasten the tongue round the chin by an indiarubber band or a piece of string. Now kneel at the patient's head, take hold of

his arms above the elbows, and carry them well over the head back as far as they will go (this will have the effect of expanding the chest, and air will generally be heard passing into it); hold the arms in this position for two seconds, then bring the arms down against the sides, cross the forearms over the stomach, lean well forward upon them, and make forcible pressure upon the abdomen, so as to press the diaphragm upwards; keep up this pressure for two seconds, this will have the effect of expelling air out of the chest. Repeat these movements carefully and

FIG. 37.—SILVESTER'S METHOD—INSPIRATION.

deliberately about fifteen times a minute till the natural respiration has been established, which will be indicated by the patient beginning to take short gasps, then cease the movements, but watch the patient carefully for some time, as the respiration may again fail after it has been restored.

2. **Dr. Benjamin Howard's 'Direct' Method.**—This method has the advantage that it can be used in cases where there is injury to the arms, and that, as the position of the patient favours the patency of the air passages, the tongue need not be attended to. It is more vigorous than the Silvester

method, it is also easily put in practice; but it has the disadvantage that, if forcible pressure is used by an unskilled operator, the patient runs the risk of being injured.

Mode of Procedure.—Lay the patient on his back, place a pillow or roll of clothing larger than that used in the Silvester method well under the back, with the shoulders slightly declining over it, the head and neck being bent back, and put the patient's hands on the top of his head. Strip the clothing from the waist

FIG. 38.—SILVESTER'S METHOD—EXPIRATION.

and neck, kneel astride the patient's hips, place the hands, with the fingers spread well apart, on the most compressible part of the lower ribs, taking care that the thumbs do not press upon the pit of the stomach; now squeeze together the two sides of the patient's chest, leaning gradually forward till the whole weight is over the patient, and the mouth is nearly over the patient's mouth; remain in this position for three seconds, then

spring back to the kneeling position, lifting the hands off the patient's sides. Continue these movements at the rate of about fifteen times a minute till the respiration is established.

3. **Professor Schäfer's Method.**—Place the patient face downwards on the ground. Bend an arm and place under the forehead in order to keep the nose and mouth clear of the ground. Stand across the patient (or kneel by his side) and then press against the lower part of the back of the chest in steady regular movements, at the rate of about fourteen to the minute.

Asphyxia.

By **asphyxia** is meant the condition which supervenes when the function of respiration has become interrupted.

Causes of Asphyxia.—1. Submersion in a liquid medium, as in drowning.

2. Occlusion of the air passages by foreign bodies, as in choking.

3. Pressure on the chest, preventing the action of the respiratory muscles.

4. Closure of the air passages, as in suffocation or smothering.

5. External pressure on the air passages, as in strangulation or hanging.

6. Breathing irrespirable gases, such as nitrogen, hydrogen, carbonic oxide, sulphuretted hydrogen, chlorine, chloroform vapour, etc.

Treatment of Asphyxia.—For some minutes (about four) after the respirations have entirely stopped the heart's action continues, and so long as it does so recovery from asphyxia is possible.

The main indications for treatment are:

1. To remove, if possible, the cause of the asphyxia.

2. To effect the purification of the blood by introducing fresh air into the lungs by means of artificial respiration or otherwise.

Treatment of Asphyxia from Drowning.—The appearances

presented by a person who has been immersed for some time in the water are as follows:

The face is swollen and purple.

The lips are livid and the eyes bloodshot.

The mouth, windpipe, and lungs contain a frothy fluid, and there is a considerable quantity of water in the stomach.

The feet and hands may be swollen and discoloured.

The body is cold.

In treating the apparently drowned, the attention must be directed to the following points:

1. The condition of asphyxia due to submersion and to the blocking of the air passages with water, mud, etc.

2. The shock to the system.

3. The exhaustion from long-continued struggling.

4. The effect of exposure to the cold.

But to remove the condition of asphyxia as soon as possible is the most important factor in the treatment.

Directions for Restoring the apparently Drowned.—1. Send immediately for medical assistance, but proceed to treat the patient instantly, securing as much fresh air as possible.

2. The points to be aimed at are, first and immediately, the restoration of breathing, and secondly, after breathing is restored, the promotion of warmth and circulation.

Treatment to restore natural breathing.—(i.) Maintain a free entrance of air into the air passages. To effect this, remove all tight clothing constricting the neck and chest; look to the mouth, and cleanse it of all mud, weeds, lumps of food, etc.; draw the tongue forward, and secure it there, if possible, by an elastic band passed over it and under the chin; look to the nostrils, and free them from any obstruction.

(ii.) Drain off any water from the chest or stomach; therefore turn the body on the face, the forehead resting on the forearm, in order to keep the mouth off the ground, the pit of the stomach being raised above the level of the mouth by a large hard roll of clothing placed beneath it. Make steady pressure upon the patient's back over the roll of clothing, so as to press all fluids in the stomach out of the mouth, and repeat it once or twice, until fluid ceases to flow from the mouth.

(iii.) If the breathing has ceased, adjust the patient's position and commence artificial respiration. To adjust the position, place the patient on his back on a flat surface, inclined a little from the feet upwards, the head and shoulders being raised and supported on a small firm cushion or folded article of dress placed under the shoulder-blades. Imitate the movements of breathing, by commencing at once Silvester's method of artificial respiration, and continue it till the patient makes an effort to breathe.

(iv.) Employ whatever other means may be available to promote recovery.

During the performance of artificial respiration, if any assistants are at hand get them to excite the nostrils with snuff or smelling-salts, or tickle the throat with a feather; to rub the face and chest briskly; to dash hot and cold water on them alternately.

Treatment to promote warmth and circulation when natural breathing has been restored.—Wrap the patient in dry blankets, and commence rubbing the limbs upwards firmly and energetically, either under or over the clothing. Promote the warmth of the body by the application of hot flannels, bottles or bladders of hot water, hot bricks wrapped in flannel, etc., to the pit of the stomach, arms, between the thighs, and the soles of the feet. When the power of swallowing has returned, give small quantities of wine, warm brandy and water, or coffee. Put the patient to bed, and encourage sleep. During reaction the breathing may become oppressed; to obviate this apply large linseed-meal and mustard poultices to the chest in front and back behind.

Watch the patient carefully for some time, to see that breathing does not fail. If any signs of failure should appear, resume artificial respiration.

Note.—The above efforts to restore life must be persevered in till the arrival of medical assistance, or until the pulse and breathing have ceased for at least an hour.

Cautions.—1. Avoid delay in the application of measures to restore life.

2. Prevent overcrowding round the patient, especially if in an apartment.

3. Avoid rough usage, and do not let the body remain on the back unless the tongue is secured.

4. Avoid attempts to give stimulants before the patient is well able to swallow.

5. Avoid hurried and irregular movements in performing artificial respiration.

6. Avoid an overheated room.

7. Under no circumstances hold the body up by the feet.

8. On no account place the body in a warm bath, unless under medical direction, and even then it should only be employed as a momentary excitant.

9. Avoid ceasing too soon the efforts at restoration.

Treatment of Asphyxia by Choking.—Choking is caused by bits of food, foreign bodies, etc., accidentally passing into the larynx. Send at once for medical assistance, but in the meanwhile make attempts to dislodge the obstruction by passing the finger, the handle of a spoon, or a button-hook, well back over the base of the tongue and drawing forwards. In doing this, the best position to place the patient in is the recumbent, with the head turned on one side. If, after the foreign body has been extracted, there should be no signs of breathing, begin artificial respiration at once, and continue it for at least half an hour.

Treatment of Asphyxia by Blocking of the Larynx, caused by Swelling of the Mucous Membrane.—Suffocation in children is frequently caused by attempting to drink from the spout of a kettle containing boiling water. Send at once for medical assistance, but proceed at once to wrap the child in a blanket, apply hot sponges, hot flannels (dry or moist), to the mouth. Administer in dessertspoonful doses salad, linseed, or cod-liver oil; also give pieces of ice to suck.

Treatment of Asphyxia from Attempted Hanging or Strangulation.—Immediately release the patient, loosen or cut any cords which may be round his neck, also all tight clothing; allow a free current of air to pass over his face; dash cold water over his chest and face, and restore breathing by artificial respiration.

Treatment of Asphyxia from breathing Irrespirable and

Poisonous Gases.—These gases include charcoal vapour; coal and coke vapour; the vapour of lime, brick, and cement kilns; coal gas; the foul air in sewers and cesspools, and in mines (choke-damp); the vapour of chloroform, etc.

Remove the patient at once from the foul air, loosen all tight clothing, draw his tongue forward and fix it, commence artificial respiration and apply friction and warmth to the body; dash cold water on his head and face.

The appearances which generally accompany death are as follows:

1. The breathing has stopped, there is no movement of the chest, the sound of air passing in and out is absent, and there is no watery vapour proceeding from the mouth.

To determine this, place a glass of water on the chest, and watch if any movement is communicated to it; hold a looking-glass or some cold bright surface to the mouth, and see if the surface becomes dimmed by vapour condensing upon it.

2. The circulation of the blood has stopped, there is no pulse, the movements and sounds of the heart have ceased.

To determine this, tie a ligature tightly round a finger; if there is any circulation, the end of the finger will become reddened, and the string will leave a white ring round the finger.

3. The eyelids are generally half closed and the pupils dilated.

4. Coldness and pallor of the surface of the body increase.

CHAPTER VI.

POISONS AND THEIR IMMEDIATE TREATMENT.

Definition—Classification—Symptoms of Poisoning—General Treatment—Special Poisons—Symptoms and Treatment.

Definition.—Poisons are substances which, when introduced into the body, or applied externally, injure health or destroy life.

Classification—1. *Corrosives.*—These soften and destroy the

mucous membrane or other parts with which they come in immediate contact. Examples of corrosive poisons: The mineral acids, the caustic alkalies, corrosive sublimate, acid, alkaline, and corrosive salts (chlorides of zinc, tin and antimony, nitrate of silver, acid sulphate of potassium, carbonate of potassium), oxalic acid.

2. *Irritants.*—These cause inflammation of the part (usually the alimentary canal) to which they are applied. Examples of irritant poisons: Arsenic, the salts of antimony, zinc and other metals, elaterium, the essential oils, Spanish fly.

3. *Narcotics.*—These act chiefly upon the nervous system, producing stupor, delirium, convulsions, or coma. Examples of narcotic poisons: Opium, prussic acid, belladonna, chloroform, chloral, alcohol, poisonous gases.

4. *Narcotico-irritants.*—These combine more or less the characters of the above two. Examples of narcotico-irritants: Strychnine, aconite, hemlock, poisonous fungi.

Evidence of Poisoning is afforded by the following circumstances: 1. By the sudden appearance of the general symptoms of poisoning (vomiting, purging, cramp, pain in the stomach or bowels, delirium, unconsciousness) in a person otherwise healthy, or soon after partaking of food, drink, or medicine.

2. By several persons being attacked with similar severe symptoms soon after a meal, of which all have partaken.

3. By the nature of the surroundings, the finding of a glass or bottle with suspicious-looking contents, the smell of the room, etc.

4. By the history of the case, the patient having shown previously a suicidal tendency, the signs of mental depression, etc.

How to act in a Case of Poisoning.—1. Send at once for medical assistance, and take care that the doctor is made acquainted with the fact that the case is one of probable poisoning.

2. During the absence of skilled attendance, proceed at once to adopt the treatment indicated below, viz.:

(i.) The general treatment applicable to a case of unknown poisoning, *should you be in doubt as to the nature of the poison taken.*

(ii.) The general treatment applicable to a case of special poisoning, *should you be aware of the nature of the poison.*

The General Treatment applicable to a Case of Unknown Poisoning.—The objects to be aimed at are:

1. To get rid, if possible, of the unabsorbed poison from the system. This is effected by administering an emetic to bring the poison up; or by administering an aperient to pass the poison through.

2. To counteract depression and shock by giving stimulants and nourishments, and applying poultices and hot fomentations.

3. To relieve pain by means of sedatives and demulcents.

Emetics.—(i.) Sulphate of zinc: 20 to 30 grains in half a tumbler of warm water. Prompt and safe.

(ii.) Ipecacuanha powder: 15 to 30 grains in warm water. Produces very little depression, and does not irritate the stomach.

(iii.) Ipecacuanha wine: one to two tablespoonfuls in water. Is not very prompt in its action.

(iv.) Mustard: a teaspoonful in a tumbler of warm water.

(v.) Salt: a tablespoonful in a tumbler of warm water.

(vi.) Tepid water: large draughts of soapy or greasy water, followed by irritation of the back of the throat by means of the finger or a feather.

Any of the above emetics may be repeated once or twice, if necessary; the action of an emetic is facilitated by giving plenty of tepid water.

Caution.—Emetics are not to be given in cases of corrosive poisoning, indicated by stains on the fingers, lips, in the mouth, etc.

Patients suffering from narcotic poisoning are not easily made to vomit.

Aperients.—(i.) Castor-oil: one to two tablespoonfuls for a dose.

(ii.) Sulphate of magnesia (Epsom salts): a tablespoonful in a tumbler of warm water. Repeat if necessary.

Stimulants.—(i.) Sal volatile (aromatic spirits of ammonia): a half to one teaspoonful in a tablespoonful of warm water.

(ii.) Spirits (brandy or whisky): from a teaspoonful to a tablespoonful, according to circumstances.

(iii.) Strong tea or coffee, by the mouth or rectum.

(iv.) Strong beef-tea, by the mouth or rectum.

(v.) Hot and cold douche.

Sedatives and Demulcents.—Bland, non-irritating fluids (which soothe internal local irritation and relieve pain), such as milk, raw eggs, barley-water, arrowroot, flour and water, olive-oil, linseed-tea, gruel, weak tea or coffee, warm water.

Special Poisons.	Their Symptoms.	Their General Treatment.
I. The Acids. (*a*) The strong corrosive ones, viz.: i. Acetic (glacial and aromatic vinegar). ii. Hydrochloric (muriatic spirits of salt). iii. Nitric (aqua fortis). iv. Sulphuric (oil of vitriol).	Immediate burning pain in mouth, throat, and stomach; vomiting may occur, followed by purging; skin and mucous membrane where touched destroyed; shock, exhaustion, and suffocation.	*Caution.* — Emetics not to be given; administer magnesia or chalk in warm water, frequently; demulcents, lime-water and milk; if depression, stimulants.
v. Carbolic (phenol).	The above symptoms, with the voidance of greenish or black urine, and the odour of acid in the breath; great depression.	Epsom salts, ½ oz. in 8 oz. of warm water; white of egg in water in large quantities; castor-oil 1 oz., or olive-oil 4 oz.; stimulants freely; warmth to extremities.
vi. Oxalic (salts of lemon or sorrel).	Burning pain in stomach; cramp in legs; dark-coloured fluid vomited; hacking cough and a feeling of constriction in the throat; purging; mouth sore and white; great shock; death may rapidly supervene.	*Caution.*—Avoid giving potash, soda, or ammonia, or carbonate of potassium, sodium, or ammonium; administer chalk and water, magnesia and water, or lime-water frequently; castor-oil, 1 oz.; stimulants.
(*b*) Prussic (hydrocyanic) acid may occur in oil of	Giddiness; staggering; insensibility; loss of power; eyes fixed, pupils	Emetics; ipecacuanha or mustard; inhalation of fumes of

Special Poisons.	Their Symptoms.	Their General Treatment.
almonds, almond flavouring, peach kernels, bitter almond water, laurel water, cyanide of potassium, Scheele's acid.	dilated, and insensitive to light; limbs flaccid; skin cold, and covered with a clammy perspiration; pulse imperceptible; respirations gasping and panting; convulsions; with a fatal dose insensibility rapidly follows.	ammonia; stimulants; sal volatile or spirits, by enema if necessary; hot and cold douche; artificial respiration to be kept up steadily, and friction of the limbs. (NOTE.—If life can be maintained for half an hour, recovery is almost certain.)
(*c*) Carbonic acid, or oxide, gas, coal gas or sewer gas, choke-damp or after-damp, charcoal fumes.	Irritation of throat; headache; drowsiness; giddiness; singing in ears; loss of muscular power; lividity; hurried respirations; coma; death.	Remove to fresh air; artificial respiration; smelling-salts; stimulants; cold to head and chest.
II. **Aconite** (Monk's-hood, Blue Rocket) and its alkaloids occur in aconite liniment, neuraline, etc.	Warmth at pit of stomach; tingling of mouth, lips, and tongue; feeling of constriction of throat; swallowing difficult; numbness of tips of fingers; loss of sensation; deafness; respirations shallow and feeble; convulsions; great prostration.	Emetics; stimulants freely; warmth to extremities; friction; patient to be kept strictly recumbent; artificial respiration if necessary.
III. **Alcohol**, as in rectified, proof, and methylated spirits, brandy, rum, whisky, gin, etc.	Giddiness; inability to stand or walk; gait tottering; expression vacant; face flushed; lips livid; breath alcoholic; skin covered with sweat; pupils dilated and fixed, but may be contracted; convulsions; stupor; coma.	Emetics; rouse the patient, and keep him awake; hot strong coffee, by mouth or rectum; alternate hot and cold douche; when patient has sufficiently recovered, rest and warmth.
IV. **The Alkalies**, strong caustic ones, viz.: i. Ammonia (spirits of hartshorn, etc.), as in caustic ammonia, ammonia lini-	Immediate burning pain in mouth, throat, and stomach; vomiting and purging; great shock and exhaustion; suffocation.	*Caution.* — Emetics not to be given; vinegar, lemon or orange juice, tartaric or citric acid, in plenty of water; demulcents; stimulants if required. If power of swallowing lost, inhalation of acetic acid or vinegar

Special Poisons.	Their Symptoms.	Their General Treatment.
ment, compound camphor liniment, liquid ammonia.		from pocket-handkerchief.
ii. Lime, as caustic lime, quicklime.		
iii. Potash, as caustic potash.		
iv. Soda, as caustic soda, soda lye.		
V. Antimony, as chloride or tartarated antimony, tartar emetic, antimonial wine. Hooper's or Holt's specific.	Metallic taste in mouth; nausea; vomiting; heat; constriction and choking in throat; pain in stomach; violent purging; cramps in limbs; skin cold; head and face congested; great depression and collapse.	Emetics; large draughts of strong tea or coffee; stimulants if collapse; warmth.
VI. Arsenic (arsenious acid, white arsenic) may occur in aqua tofana, fly-papers, mineral Vienna and Scheele's emerald green, Fowler's solution, Simpson's rat paste and vermin killers (Roth and Ringeisen's), cheap ices, wall-papers, cheap crayons, and French chalks. Tinned fruits (as an impurity of the tin).	Faintness; depression; burning pain in stomach; nausea; vomiting; may be blood in vomit; purging; severe cramp in legs; constriction and dryness of throat; great thirst; hiccough; loss of voice; cold sweats; great shock and exhaustion.	Emetics, followed by plenty of warm water to wash out the stomach; dialyzed iron in ounce doses, or magnesia, frequently repeated; olive-oil and lime-water, in large doses, frequently repeated; stimulants freely, if prostration; demulcents; warmth and friction; after acute symptoms relieved, linseed poultices to abdomen.
VII. Belladonna (Deadly Nightshade) and its alkaloid atropine.	Heat and dryness of mouth and throat; great thirst; difficulty in swallowing; face flushed; eyes prominent, pupils dilated; excitement; de-	Emetics; strong coffee enema; stimulants; mustard to calves of legs; hot-water bottles to feet; alternate hot and cold

Special Poisons.	Their Symptoms.	Their General Treatment.
	lirium: gait unsteady and staggering; skin dry, with perhaps a red rash on it.	douche; artificial respiration.
VIII. **Cantharides** (Spanish fly, blister beetle, blistering fluid).	Same as arsenic-poisoning.	Emetics; demulcents (avoid fats and oils); when acute symptoms relieved, hot baths or linseed-meal poultices to the abdomen.
IX. **Camphor**, as in essence, liniment, spirits of camphor, Rubini's solution.	Odour of breath; languor; giddiness; faintness; delirium; convulsions; cold and clammy skin; difficult breathing.	Emetics; stimulants; warmth and friction to extremities; alternate hot and cold douche to head and chest.
X. **Caustic, Lunar** (nitrate of silver).	Pain and discoloration of mouth and throat; vomiting of whitish, flaky matter, which turns black.	Common salt, dissolved in water or milk, freely; emetics, except sulphate of zinc; demulcents.
XI. **Chloral** (chloral hydrate, syrup of chloral, Hunter's chloral).	Deep sleep; loss of muscular power; face livid and bloated; pulse slow; respirations diminished; surface of body cold.	Emetics; warmth and friction; keep patient roused by shouting, cold towels, etc.; strong coffee enema, and repeat it if necessary; artificial respiration to be kept up if necessary.
XII. **Chlorine Gas**, as in chloride of lime and other irritant gases.	Irritation of throat; cough; tightness of chest; difficulty of breathing; inability to swallow.	Fresh air; inhalation of steam; inhalation of very dilute ammonia.
XIII. **Chloroform** (inhaled). **Bichloride of methylene, ethidene, dichloride.**	Arrested respirations; stertorous breathing; face livid.	Pull forward tongue; see mouth and throat are clear; loosen everything about throat and chest; plenty of fresh air; hot and cold douche alternately to head and chest; artificial respiration.
XIV. **Chloroform** (swallowed).	Odour of breath; pain in throat, stomach, and over abdomen; great depression; insensibility; pupils dilated; breathing	Emetics; carbonate of soda in plenty of water; rouse patient in every possible way; douche; friction;

Special Poisons.	Their Symptoms.	Their General Treatment.
	stertorous; skin cold; pulse imperceptible.	enema of strong coffee; demulcents.
XV. **Copper**, as the sulphate (blue vitriol, blue stone), the acetate (copperas, verdigris).	Metallic taste in mouth; constriction in throat and gullet; pain in abdomen; vomiting; purging; difficult breathing; great weakness; thirst; cold perspirations; coldness of limbs; headache; giddiness; coma.	Emetics (if no vomiting), followed by large draughts of tepid water; demulcents freely; poultices to abdomen if pain.
XVI. **Croton-oil.**	Great pain in abdomen; vomiting; purging; watery stools; face pale and pinched; skin moist; great collapse.	Emetics; demulcents; stimulants freely; poultices to abdomen.
XVII. **Ergot of Rye** and its alkaloids, ergotine, etc.	Tingling and cramp of limbs; dizziness; weakness; retching; vomiting; diarrhœa.	Emetics; castor-oil 1 oz.; stimulants; warmth and poultices.
XVIII. **Ether** (inhaled).	Same as chloroform inhaled.	Same as chloroform inhaled.
XIX. **Fungi** (fly fungus, poisonous mushrooms).	Violent colic, with vomiting and diarrhœa; great excitement, then coma; pulse slow; breathing stertorous; pupils dilated; extremities cold.	Emetics; castor-oil 1 oz.; stimulants; warmth to extremities; poultices to abdomen.
XX. **Holly Berries.**	Vomiting; pain in head and abdomen; purging; pupils contracted; drowsiness; unconsciousness; collapse.	Emetics; stimulants freely; friction; warmth; coffee enema.
XXI. **Hyoscyamus** (henbane) and its alkaloids, hyoscyamine, etc.	Much the same as belladonna—thirst; dilated pupils; delirium.	Emetics; stimulants moderately; coffee enema; hot and cold douche alternately.
XXII. **Iodine.**	Pain and heat in throat and stomach; purging; vomited matter may be yellow or blue; stools may contain blood; giddiness; faintness.	Emetics; starch and water; arrowroot, or gruel, or white of egg and water, freely.
XXIII. **Laburnum** and its active principle cytisine in arnica.	Purging; vomiting; great restlessness, then drowsiness; insensibility, with convulsive twitchings.	Emetics; stimulants, moderately hot coffee enema; hot and cold douche alternately.

Special Poisons.	Their Symptoms.	Their General Treatment.
XXIV. **Lead**, as acetate (sugar of lead). Lead paint or white lead may occur in crayons, French chalk, hair dyes.	Vary widely; generally much delayed; dryness of throat; metallic taste; great thirst; colic about navel, which is relieved by pressure; always constipation; cramp in legs; paralysis of lower extremities; convulsions.	Emetics; Epsom salts freely; demulcents; poultices to abdomen.
XXV. **Mercury**, as corrosive sublimate, perchloride of mercury, red and white precipitate, red oxide of mercury; the acid nitrate of mercury.	If corrosive sublimate or acid nitrate taken—lips and mouth white and swollen; tongue white and shrivelled; sense of constriction in throat; in all cases: metallic taste in mouth; pain in the stomach; nausea; vomiting of stringy mucus mixed with blood; profuse purging, with bloody stools; skin cold and clammy; respirations difficult; syncope; convulsions.	Emetics; raw white of egg mixed with water, freely; demulcents; stimulants.
XXVI. **Mussels.**	Weight at pit of stomach; numbness in extremities; heat, dryness, and constriction in mouth and throat; thirst; shivering; difficult breathing; cramp in legs; swelling of eyes; colic; vomiting; purging; itching of skin; collapse.	Emetics; castor-oil 1 oz.; stimulants very freely; hot-water bottles to feet; warmth and friction.
XXVII. **Nitrous Oxide Gas** (laughing gas).	Same as chloroform inhaled.	Same as chloroform inhaled.
XXVIII. **Nitro-Benzol**, as in aniline dyes, liqueurs, sweetmeats, pomades.	Weakness; discomfort; nausea; great anxiety; confusion of mind; cyanosis often very marked; pupils dilated; may be convulsions.	Emetics; stimulants freely by mouth or enema; inhalations of ammonia; hot and cold douche alternately; artificial respiration.
XXIX. **Nux Vomica** (St. Ignatius' Bean) and its alkaloid, strychnine, as in Butler's.	Violent rigid convulsions; lockjaw during the convulsive attack; pupils dilated; respirations impeded; pulse feeble; death	Emetics; animal charcoal, followed by an emetic; artificial respiration if possible.

Special Poisons.	Their Symptoms.	Their General Treatment.
Battley's and Gibson's Vermin Killer.	from asphyxia or collapse.	
XXX. **Opium** (laudanum) and its alkaloids (morphine, codeine, etc.) occur in tincture and wine of opium, Battley's Sedative Solution, Black Drops, Chlorodyne, Dalby's Carminative, Godfrey's Cordial and Elixir, Mother's Friend and Soothing Syrup, Nepenthe, Syrup of Poppies.	Excitement, followed by headache; weariness; a sensation of weight in the limbs; sleepiness; loss of sensibility; contraction of the pupils; at first difficult to rouse the patient; later on he becomes quite insensible; muscles become relaxed; skin cold; face and lips cold and blue; respirations slow, irregular, and stertorous.	Emetics; rouse and keep the patient awake in every possible way by making him walk about; flap him with a wet towel, etc.; ammonia or sal volatile to nostrils. Do not give wine or brandy. Strong hot coffee by mouth or rectum; cold douche to head frequently. Artificial respiration to be kept up for at least two hours.
XXXI. **Paraffin-oil.**	Symptoms vary; burning sensation in mouth, gullet, or stomach; body and extremities cold; face pale; pulse feeble; respirations weak; great thirst; often coma.	Emetics; stimulants freely; warmth to extremities.
XXXII. **Phosphorus**, as in matches, phosphorus paste, rat poison, vermin killer, rat paste (Roth and Ringeisen's, with arsenic).	Pain in stomach; vomiting; vomited matter luminous in the dark; odour in breath; bleeding from nose; vomiting of blood; blood-stained motions; convulsions.	Emetics; Epsom salts, ½ oz. in water (avoid oils and fats); stimulants or demulcents if required.
XXXIII. **Tin** and its Salts.	Same as lead.	
XXXIV. **Tobacco** and its active principle, nicotine.	Nausea; vomiting; great weakness; faintness; confusing ideas; dimness of sight; weak pulse; cold and clammy skin; pupils at first contracted and then dilated.	Emetics; strong tea; stimulants freely; warmth and friction; recumbency.
XXXV. **Turpentine** (oil and spirit of turpen-	Odour in breath; intoxication; pupils contracted; stertorous	Emetics; Epsom salts, 1 oz. in water; demulcents.

Special Poisons.	Their Symptoms.	Their General Treatment.
tine, turps, camphene).	breathing; coma; collapse; convulsions; frequent desire to pass water. Some resemblance to opium-poisoning.	
XXXVI. Zinc, as sulphate (white vitriol), chloride (Burnett's fluid).	Lips and mouth corroded; pain and burning in throat and mouth; vomiting of blood-stained fluid; difficulty in swallowing; pulse and respirations quick; pupils dilated; convulsions; coma.	Bicarbonate of soda, or common soda, in large quantities, dissolved in warm water; demulcents freely; strong tea; poultices to abdomen; gruel enema, if pain; avoid common salt.

CHAPTER VII.

THE IMMEDIATE TREATMENT OF INSENSIBILITY AND FITS.

Causes of Insensibility—Syncope or Fainting—Shock—Concussion and Compression of the Brain—Apoplexy—Alcoholic Intoxication—Narcotic Poisoning—Sunstroke—Freezing. *Fits:* Epileptic—Hysterical—Children's—Uræmic Convulsions.

Insensibility.

COMPLETE loss of consciousness may be produced by any of the following causes:

1. Syncope or fainting.
2. Asphyxia.
3. Shock and collapse.
4. Concussion of the brain.
5. Compression of the brain.
6. Apoplexy.
7. Alcoholic intoxication.
8. Narcotic poisoning, as opium-poisoning.
9. Sunstroke.
10. Freezing.

Unconsciousness is also present in the following:

1. Epilepsy.
2. The convulsions of children.
3. Uræmia (poisoning from kidney disease). But here the most prominent feature is the presence of convulsions.

These diseases are dealt with separately under Fits.

1. Syncope or Fainting—*Causes.*—Mental emotion, extreme exhaustion (as from hunger, fatigue, etc.), hæmorrhage, cold, heat (particularly if combined with a close atmosphere, as in heated rooms, large crowds, etc.), constriction of the chest (as in tight-lacing), and organic disease of the heart.

Symptoms.—Fainting is generally ushered in by a feeling of giddiness and fluttering at the heart; the face then suddenly becomes pale and the lips white; the pulse is weakened and the breathing quickened; a cold sweat appears on the brow, and the patient staggers and falls to the ground in an unconscious state.

Treatment.—As fainting is caused by a diminution of the supply of blood to the brain, the object to be aimed at in treatment is to restore the cerebral circulation; therefore, when a person has fainted, do not attempt to place him in a sitting or standing posture (as this will only embarrass the already weakened action of the heart, and may be fatal), but lay him flat on his left side, with his pelvis and feet slightly raised, loosen all tight clothing about his body and neck, give him plenty of fresh air, sprinkle cold water in his face, apply smelling-salts to his nostrils; when able to swallow, give him a glass of water, or a little brandy, whisky, or sal volatile and water, and keep him lying down in the recumbent position for some time.

If the faint is prolonged, and loss of consciousness does not return, send for medical assistance, but in the meanwhile apply warmth to the feet, a hot mustard-plaster over the heart, and, if the natural breathing has not returned, perform artificial respiration.

In a crowded room, a fainting-fit may be prevented by placing the patient in a stooping position on a chair, and bending his head between his knees. If the patient has completely fainted away, this treatment is not to be attempted, as it only helps to obstruct the circulation and the respiration.

2. Asphyxia.—This has been treated in Chapter V.

3. Shock or Collapse—*Causes.*—Severe injuries or emotional disturbance, causing a profound depressing effect upon the central nervous system.

The injuries most liable to produce shock are:

(i.) Those involving large surfaces of the skin, as in burns and scalds.

(ii.) Those causing crushing or tearing of the body, such as occur in machinery and railway accidents.

(iii.) Those affecting the abdominal viscera.

Loss of blood and exposure to cold intensify the condition of shock.

Symptoms.—A person in a state of shock presents the following appearance: He lies flat on his back, his limbs are flaccid and he makes no spontaneous movements, his body is cold and clammy, his face pale, his eyes sunken, his pulse small, feeble and irregular, his respirations shallow, feeble and sighing, his temperature about 97°, or a degree or two lower, and consciousness more or less impaired.

Should a case of shock terminate favourably, a condition known as 'reaction' comes on; the patient usually vomits, his pulse becomes stronger, his body warmer, and colour returns to his face.

Treatment.—The object of treatment here is to bring about reaction by the application of warmth and the administration of stimulants. Therefore place the patient in bed as soon as possible between blankets, keep his head low, apply hot-water bottles to his feet and between his thighs, and apply friction to his arms and legs. If able to swallow, give him small quantities of stimulants, frequently repeated, till reaction shows itself, then lessen the stimulants. If during the state of collapse the breathing should become embarrassed, perform artificial respiration.

4. Concussion of the Brain—*Causes.*—Usually due to blows, or falls upon the head, or falls upon the feet or lower end of the spine, the blows having the effect of severely shaking up the brain substance.

Symptoms.—These vary in their severity, according to the force of the blow applied. The patient may present the appear-

ance of being merely stunned, or he may be in a condition identical with that described in a case of shock.

Treatment.—Adopt that described for shock, but apply cold in the form of ice or wet cloths to the head. Avoid the alcoholic stimulants, but administer hot beef-tea or hot coffee, and keep the patient absolutely quiet in a darkened room.

5. **Compression of the Brain**—*Causes.*—Injuries to the head, producing pressure on the brain substance, either by the depression of a piece of bone on to it, or by a blood-clot resulting from the rupture of a bloodvessel.

Symptoms.—These resemble those of apoplexy, which see.

Treatment.—If there is a wound in the head, dress it; otherwise adopt the same treatment as for apoplexy.

6. **Apoplexy**—*Causes.*—Usually the result of the bursting of a diseased bloodvessel in elderly people, in the substance or on the surface of the brain, causing compression.

Symptoms.—The patient is more or less unconscious; the face is flushed; the breathing is deep, slow, and stertorous; the eyes are insensitive to light and touch, and the pupils are unequally dilated, or one or both pupils may be contracted; the pulse is full and slow; and there is paralysis affecting one side of the body.

Treatment.—The object of treatment is to get the circulation quiet and the heart's action as free from embarrassment as possible; therefore loosen all tight clothing about the neck and chest. Put the patient to bed, keeping his head raised, and apply cold to it; apply hot-water bottles to his feet. Give no stimulants, and send for medical assistance.

7. **Alcoholic Intoxication**—*Symptoms.*—A person in a state of stupor from alcohol presents the following picture:

He is unconscious, but can be partially roused; his face is flushed and bloated; his eyes are reddened and bloodshot, but are not insensitive to touch; his pupils are equal, dilated and fixed; his lips are livid; his breathing is slow; the surface of the body is cold; and he may smell of liquor.

Note.—Alcoholic stupor may be hard to distinguish from apoplexy; but the state of the pupils, the sensitiveness of the eye to touch, and the presence or absence of paralysis, will help to determine the condition.

Treatment.—See Poisons, Chapter VI.

Caution.—If in doubt as to whether a person is suffering from apoplexy or drunkenness, treat him for the former, and be particularly careful not to make him vomit.

8. **Narcotic Poisoning**—See Opium-poisoning, Chapter VI.

9. **Sunstroke**—*Causes.*—Exposure to the rays of the sun.

Symptoms.—There is giddiness, nausea, and weakness, followed by drowsiness and more or less unconsciousness. The eyes are bloodshot; the skin is hot and dry; the breathing is quick and noisy; the pupils are contracted at first, and then become dilated; the pulse may be slow or quick.

Treatment.—Place the patient in the shade; remove his clothing; douche his head, neck, chest, and spine with cold water, or wrap cold sheets round him; continue these cold applications till he becomes conscious. Keep him in a darkened room. Watch him carefully. If the unconsciousness returns, renew the application of cold.

10. **Freezing.**—*Treatment.*—Rub the body with ice-cold or snow water; restore warmth gradually. It is dangerous to apply heat too early. As soon as the patient is able to swallow, give him stimulants and hot drinks.

Fits.

1. **Epileptic Fits.**—The distinguishing features of these fits are convulsive movements and unconsciousness. An epileptic fit is usually ushered in by the patient giving a cry or shriek, falling down, and all the muscles of his body becoming perfectly rigid. This stage of rigidity is succeeded by a stage of convulsions, in which the patient's body is thrown into a state of violent twitchings and contortions, with foaming at the mouth; and during this stage the tongue may be bitten. After the convulsive stage has lasted a few minutes, it is followed by a period of partial unconsciousness, which may continue for a variable period, and the patient then finally falls into a deep sleep.

Treatment.—During the convulsive stage place the patient in a safe position, and prevent him from hurting himself; put a piece of wood or other hard substance between his teeth, to prevent him from biting his tongue; loosen all tight clothing about

his neck, chest, and abdomen; and do not attempt to administer anything by the mouth.

After the convulsive stage has passed off, and the patient seems drowsy, encourage natural sleep. If on waking he seems exhausted, give him a little soup or beef-tea, but no stimulants.

2. **Hysterical Fits.**—These occur more often in females than males, and are ushered in by crying, sobbing, or laughing, without any obvious cause; jerky movements of the limbs occur (not truly convulsive); the breathing is quickened; the eyelids are closed. In severe attacks the patient falls down, apparently unconscious, but takes care never to hurt herself.

Treatment.—The best plan of treatment is to let hysterical patients alone, and exclude all fussy friends. As the patient begins to realize that her condition is exciting no sympathy or alarm, she will soon come to herself.

3. **Children's Fits.**—These are usually caused by teething, constipation, indigestion, etc.

Before a fit comes on the child is usually fretful and peevish.

A fit is ushered in by the muscles twitching; the body then gets stiff, and the limbs begin to jerk; the pulse is rapid and weak; the breathing is hurried; the skin is wet with cold, clammy perspiration. The child then falls into a sound sleep, or the fit may be repeated. During the fit there is complete loss of consciousness.

Treatment.—Place the child in a warm bath, at a temperature of 90° Fahr., from ten to twenty minutes; place cold sponges on the head, constantly changing them, and send for medical assistance.

4. **Convulsions from Uræmia** (Kidney Disease).—These may come on suddenly in the course of Bright's disease. They may vary in degree from mere twitchings of the body to general convulsions, with complete unconsciousness.

Treatment.—Send for medical assistance. In the meanwhile apply cold to the head and a mustard-plaster across the small of the back; place the patient in warm blankets, and apply hot-water bottles to his feet, the object here being to encourage sweating.

CHAPTER VIII.

BURNS, SCALDS, FROST-BITE, AND THEIR IMMEDIATE TREATMENT.

Burns and Scalds—Degrees—General Local Treatment—Burns by Acids and Alkalies—Burning Clothing—Frost-bite.

Burns and Scalds.

BURNS are caused by the application of fire or dry heat, scalds by the application of hot liquids or moist heat.

Degrees of Burns.—Burns are divided into the following degrees:

First degree—a mere reddening of the skin.

Second degree—the formation of blisters.

Third degree—charring.

Burns and scalds, in addition to the actual destruction of the tissues, produce:

1. Shock, which is in direct proportion to the superficial extent of the burn. Burns of the abdomen and chest are especially liable to produce marked shock, and in children suffering from burns and scalds shock is usually profound. Exposure to the air especially aggravates the condition of shock.

2. Congestion of the internal organs.

Treatment.—In the management of burns and scalds two points have to be borne in mind:

1. The treatment of the local injury.

2. The treatment of shock.

If the shock is severe, treat it first, and wait till reaction sets in before treating the local injury.

The Treatment of the Local Injury.—In attending to this, care should be taken that the clothing is removed with the utmost care from the burnt part, and that no blisters are broken. The clothing should be cut off, and if parts of it adhere, they should be removed by soaking them in oil; and if this is not sufficient, the part should be immersed in a bath of warm water.

If the burns are extensive, only one part of the body should be dressed at a time, the rest being kept covered up.

To dress the burns proceed as follows:

Apply over the part pieces of lint which have been soaked in either Carron-oil (a mixture consisting of equal parts of linseed-oil and lime-water) or in carbolic oil (1 part of carbolic oil in 40 parts of olive-oil), or in a saturated solution of common washing soda; or spread upon pieces of lint boracic acid ointment (which has been diluted with an equal part of vaseline), and apply it; or paint the part with a saturated solution of picric acid, and cover it up with cotton-wool.

Burns caused by Acids.—Drench the parts first with water; then wash in a solution of washing soda and water, and treat as an ordinary burn.

Burns caused by Alkalies.—Drench the parts with water; then wash in a solution of dilute vinegar and water, and treat as an ordinary burn.

Burning Clothing.—To extinguish the flames from burning clothing, make the person lie down, and quickly cover him up with a rug, coat, shawl, blanket, or other similar article.

Frost-bite.

Treatment.—Take the patient into a house with no fire in it; rub the part with snow or ice-cold water till the circulation has been restored to it.

Caution.—Do not take him into a warm room, or set him by a fire, or use warm applications.

FOOD FOR THE SICK. By Mary Truman, M.R.B.N.A., and Edith Sykes, A.R.S.I. Crown 8vo., paper covers, price 3d. (Allman & Son, Ltd., 67, New Oxford St., London, W.C.)

THE TRANSPORT OF THE WOUNDED.

Position—Single Bearer—Hand Seats—Other Improvised Seats—Stretchers — Improvised Stretchers — Loading and Unloading — Position of Patient—Carriage of Stretchers—Longmore's Rules—Carts and Waggons.

The Position of Wounded Persons during Transport.—This will depend upon the nature, the extent, and the site of the injury.

1. *The Sitting Posture* is applicable to those who are slightly wounded in the upper part of the body, and in whom there are no constitutional symptoms present.

2. *The Semi-recumbent Posture* is applicable to patients who are wounded in the region of the chest, and are suffering more or less from dyspnœa.

3. *The Recumbent Posture* is applicable to those who are severely, dangerously, or mortally wounded, and to all those who with slight wounds show signs of faintness, shock, or a tendency to hæmorrhage.

Patients suffering from the following injuries should always be removed in the recumbent posture:

Fractures of bones.

Wounds of the joints of the lower extremity.

Severe wounds of the head, chest, or abdomen.

Extensive injuries of the shoulder-joint.

Before removing a patient, care should be taken to render the necessary 'first aid' treatment required to control any urgent symptoms, and to set his chest free by loosening his clothes.

1. Removal by the Help of Single Bearers.—A single bearer, if he is strong enough, may remove a patient who is wounded in the head, neck, or upper part of the trunk, but whose extremities are uninjured, by carrying him 'pick-a-back' or *en cheval* fashion; or if this is not possible, he can remove him in the following manner:

The patient partly supports himself with a walking-stick, or some similar support, in one hand, while with his other arm and hand he encircles the upper part of the back and distant shoulder of the bearer, who walks by his side, and helps to support him by passing his near arm across the patient's back.

2. Removal by the Help of Two Bearers on Hand Seats and other Improvised Seats.—The hand seats employed are:

The two-handed seat.
The three-handed seat.
The four-handed seat.

The Two-handed Seat.—This is suitable for those who are more or less helpless, and have to be lifted from the ground.

Method of forming the Seat.—The bearers take up their position on the right and left of the patient, face inwards, and kneel down on the knee nearest his feet. They then place their hands beneath the patient's armpits, and raise him into a half-sitting position against their other knees. Now, passing their front arms beneath the patient's thighs, and locking the fingers, with the palms uppermost, they form the seat, and, rising steadily together, lift the patient from the ground, and at the same time they place their disengaged hands on each other's hips to afford a support for the patient's back, who, if he is able, is instructed to pass an arm round the neck of each bearer.

The objections to the two-handed seat are:

(*a*) It is very trying to bearers, and cannot be endured for any long distance.

(*b*) The entire weight of the patient is thrown on the two arms, and chiefly on the interlaced fingers, consequently, to meet the strain, only a limited number of muscles can be brought into action.

The Three-handed Seat.—This is suitable for patients who can support themselves more or less while being lifted. It is

unsuitable for patients in a fainting condition, as they are carried rather high up, and may tumble forwards.

This seat is firmer than the two-handed seat, and as the bearers can turn more to the front, they can march better with it than with either the two- or the four-handed seat.

Method of forming the Seat.—The bearers place themselves on the right and left of the patient, and turn inwards. The bearer on the right grasps his own left forearm with his right hand, and with his left hand he grasps the left forearm of the bearer on the left. The latter grasps with his left hand the right forearm of the bearer on the right, and places his right, or disengaged, hand on the left shoulder of the right bearer. The two bearers, then stooping, place the seat thus formed beneath the patient's hips, and lift him, while the patient at the same time helps to support himself by clasping each bearer round the neck.

The Four-handed Seat.—This is suitable for those patients who are well able to support themselves by placing their arms over the shoulders of the bearers. The seat is an easy and secure one for the person who is carried, and as the ordinary muscles of the arm are used, the weight is well borne by the bearers.

Method of forming the Seat.—The bearers, after taking up their positions, one on each side of the patient, turn inwards; each grasps his own left wrist with his right hand, and his colleague's right wrist with his left hand; they then stoop, and pass the seat thus formed beneath the hips of the patient, who seats himself firmly on it, passing his arms round the shoulders of the bearers as they rise up to the erect position.

Note.—In forming any of the hand-seats, the bearers can by pressing strongly inwards towards one another greatly increase the ease of carrying.

Two bearers can remove a man in a horizontal position thus:

Both bearers place themselves on the same side of the patient, No. 1 bearer opposite his shoulders, No. 2 bearer opposite his hips, and kneel down. No. 1 bearer now passes his hands under the shoulders and back of the patient, No. 2 bearer passes his hands under the patient's thighs and calves; the two then rise

steadily together. The patient, if he is able, clasps with his two hands the shoulders of No. 1 bearer.

Other Improvised Seats.—These can be constructed out of canvas straps, a conveniently-shaped board, etc., and on these patients can be carried in a comfortable position, with less fatigue to the bearers than is experienced with the hand seats.

3. Removal on Stretchers.—This may be done either on what is known as the Regulation Field Stretcher Mark V., or on improvised stretchers.

Stretcher when closed.—Stretchers, if neglected, become stiff and get out of order; therefore keep them in a dry store, leaning at an angle against the wall. From time to time open and air them. If the canvas becomes dirty, scrub it with a little soap and plenty of water; polish the woodwork with some oil waste; and oil the hinges from time to time. Work soft soap into the leather slings till they become soft and pliable.

Stretchers should never be folded up with the slings lying loosely upon them.

Improvised Stretchers.—Stretchers may be improvised in various ways; but those methods are the best by means of which a stretcher can be easily and efficiently constructed at the time and on the spot, such as—

1. *The Rifle Stretcher.*—Formed of two rifles, with fixed bayonets, and a blanket or rug.

Method of forming the stretcher: 'Spread a blanket on the ground, lay two rifles on it parallel to one another—each 10 inches from the centre of the blanket—both muzzles pointing in the same direction—trigger-guard outwards; turn a fold of the blanket, 6 inches wide, over the ends of the butts; fold the right side of the blanket over the rifle on that side to the rifle on the opposite side; then similarly fold the left side. A stretcher is thus formed, consisting of three folds of blanket, the end at which the butts are being the head end.' To lift it two bearers are required on each side; they grasp the rifle with both hands—near the end with one, and near the middle with the other; in carrying they must walk sideways.

Caution.—Before using the rifles, inspect them; if they are loaded, withdraw the cartridges and empty the magazines.

2. *The Blanket Stretcher.*—'Made by a rug or blanket being placed on two poles of sufficient length and thickness, and the sides rolled in and tied, with two pieces of wood attached to them to keep the sides from approximating to one another.'

3. *The Great-coat Stretcher.*—Made thus: A great-coat is procured, the sleeves are turned inside out, a rifle or pole is passed through each sleeve, and the coat buttoned up. Two short coats or jackets may be used together in a similar manner.

Loading and Unloading Stretchers—(i.) *With Four Bearers.*—In lifting a patient with a fracture of the thigh on to a stretcher, the stretcher is to be placed on the opposite side to the injury, and one of the bearers must pass one hand and arm under, and the other over, the limbs to support the fracture, while the others attend to the lifting and moving of the patient.

(ii.) *With Three Bearers.*—Place the stretcher at the patient's head, and in a line with his body. To lift the patient either on to or off the stretcher, one bearer, placing himself on the injured side in a line with the patient's knees, raises and supports the limbs. The other two bearers kneel on opposite sides of the patient near his hips, facing each other; they pass their arms under the back and thighs of the patient, and interlocking their fingers, raise and support the trunk. The bearers then rise to the erect position, and carry the patient, head foremost, either on to the stretcher, over the foot, or off the stretcher, over the head.

(iii.) *With Two Bearers.*—The stretcher is placed as in (ii.). If one of the lower limbs is severely injured, or if there are symptoms of shock, both bearers place themselves on the injured side, one in a line with the patient's knees, and the other near his hips; they then raise the patient, keeping him as far as possible in a horizontal position. If the lower limbs are intact, or only slightly injured, the patient is lifted by one of the improvised hand-seats. In either case the patient is carried, head first, on to the stretcher over the foot, or off the stretcher over the head.

The Position of the Patient on the Stretcher.—Before placing a patient on a stretcher, notice the part injured and the nature of the injury. In all cases it is important that the

head should be kept low, and care should be taken that it is not pressed forward on the chest.

For Wounds of the Head.—Place the patient in such a position as to avoid any pressure against the injured part.

For Wounds of the Lower Limb.—Place the patient upon his back, inclining towards the injured side.

For Wounds of the Upper Limb.—Place the patient on his back or on the uninjured side.

For Wounds of the Chest.—Place the patient with his chest well raised and his body inclined towards the injured side.

For Wounds of the Abdomen:

(*a*) If the wound is transverse or punctured, place the patient on his back, put a pack or other article in his hands to keep his knees bent, and then flex the thighs well over the belly.

(*b*) If the wound is vertical, place the patient on his back and extend the legs.

The Carriage of Stretchers.—Two main objects are to be kept in view in carrying patients on stretchers, viz.:

To prevent as much as possible the impulse connected with the progression of the bearers from being communicated to the stretcher.

To keep the stretcher level and as near the ground as is consistent with free carriage and the absence of risk of contact.

Rules for the Carriage of Stretchers (Longmore).

Rule 1. 'The front and rear bearers must "break" the step by starting with opposite feet. By this means the stretcher is kept level, and does not "dip" from side to side.

Rule 2. 'The pace should be 18 inches, and made with a steady but easy step, particularly avoiding elevation of the bodies by springing from the fore part of the feet. The foot should be firmly planted and the knees slightly bent.

Rule 3. 'The slings should be lengthened or shortened by the buckle till the extremities of the loops reach the wrists of the bearer standing at attention.

Rule 4. 'The bearers should, as far as possible, be of a uniform height, build, and age.

Rule 5. 'As most ground over which bearers have to carry wounded presents irregularities of surface, it becomes an important matter for bearers to practise the transport of wounded under those circumstances, and so keep the stretcher level. The concerted action of the bearers is the principle upon which this rule is based.

Rule 6. 'A sick or wounded person should as a rule be carried with his face in the direction in which the bearers walk.

Rule 7. 'If the bearers have to carry a sick or wounded man uphill, the patient is taken head first, and the reverse takes place going downhill.

Rule 8. 'With fractures of the lower extremity, as a rule, the patient should be carried uphill feet first, and downhill head first, in order to prevent the weight of his body pushing the upper end of the broken bone down upon the helpless and motionless portion of the limb below the seat of fracture.

Rule 9. 'No attempt should ever be made to carry a helpless patient over a high fence or wall, if it can possibly be avoided, as such is always a dangerous proceeding. A portion of the wall should be thrown down, or a breach in the fence made so that the patient may be carried through on the stretcher; or if this be not practicable, the patient should be carried to a place where a gate or opening already exists.

Rule 10. 'In crossing a ditch or stream, the stretcher should be first laid upon the ground near its edge. The two leading bearers should descend into the ditch, and, assisted by the two other bearers, advance the stretcher until the near end rests on the ground above; the two other bearers descend, and all four raise the stretcher and carry it to the opposite side, and the fore part being now made to rest upon the edge of the ground, while the rear part is supported in the ditch, the two leading bearers jump out of the ditch, and with the remaining bearers carry the stretcher until the near end rests upon the ground. The bearers then resume the carriage of the stretcher. In crossing a narrow ditch the bearers on either side jump in and steady the stretcher, so as to allow the head bearer to cross without shaking the patient.

Rule 11. 'Patients should never be carried with the stretcher

supported upon the shoulders. It is a most dangerous and hazardous position.

Rule 12. 'Each of the four bearers to every stretcher must understand his particular duty intelligently. The front and rear bearers attend to the carrying of the stretcher, and the two remaining carry the haversack and the water bottle. Carefully watch the patient, and assist and change with those responsible for the carriage, as occasion may require.'

If a stretcher has to be carried over ground which presents a general ascent, and the bearers are of different heights, the bearer at the rear end of the stretcher should be the taller. Should the ground present a general descent, then the front bearer ought to be the taller and stronger.

Country Carts and General Service Waggons.—When it is necessary to use these, the floors should be thickly covered with straw, on which the stretchers are to be placed.

For loading and unloading wounded on stretchers, the front end of the stretcher is first rested on the floor of the waggon; the bearers of that end then get into the waggon, and the stretcher is moved forward into its place and securely lashed.

For loading a waggon with wounded, if no stretchers are available, the wounded must be lifted as in stretcher drill, and carried to the waggon. 'On arriving at the back of the waggon, one bearer will get into it, and, supporting the wounded man under both shoulders, will lift him in, assisted by the other bearers, who will subsequently get into the waggon and help to place the wounded man in the most advantageous position possible.'

Unloading is the converse of this proceeding.

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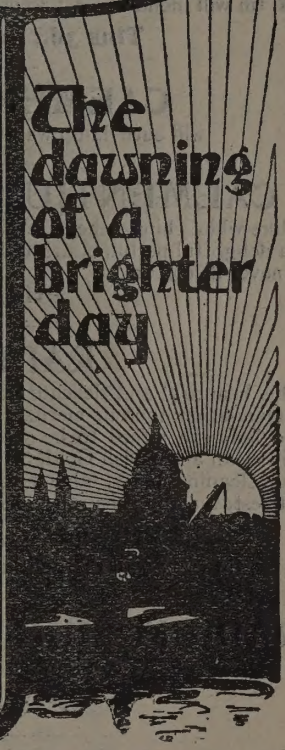

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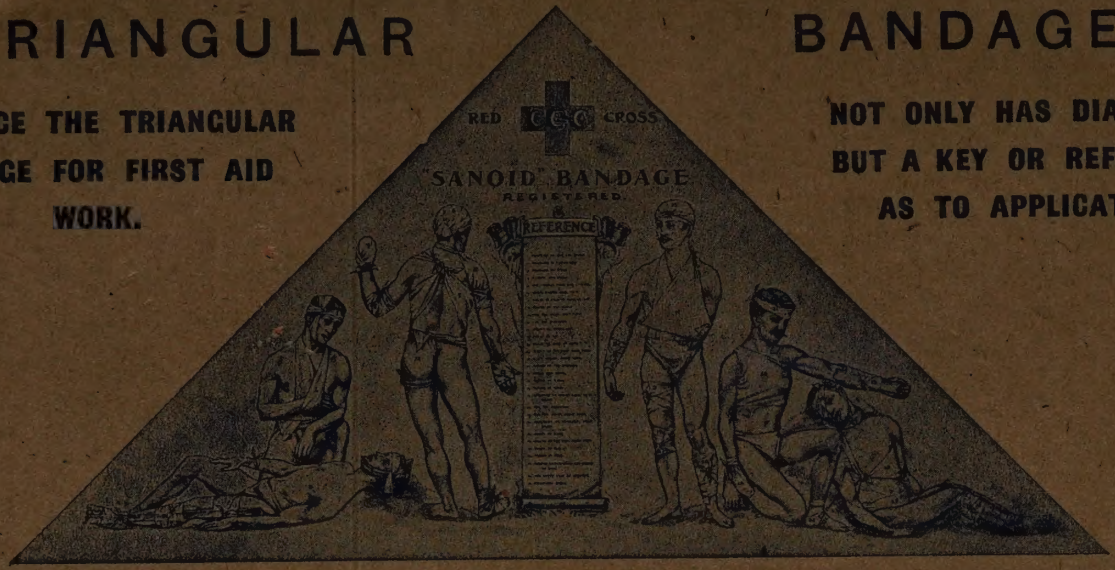

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